AMERICAN MACHINIST

A JOURNAL FOR MACHINISTS, ENGINEERS, FOUNDERS, BOILER MAKERS, PATTERN MAKERS AND BLACKSMITHS.

VOL. 18, NO. 30. WEEKLY. | NEW YORK, THURSDAY, JULY 25, 1895. | $3.00 per Annum. SINGLE COPIES 6 CENTS.

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ENTERED AT POST OFFICE, NEW YORK, AS SECOND CLASS MATTER.

Electricity on the Nantasket Branch, N. Y., N. H. & H. R. R.

The Nantasket branch of the New York, New Haven & Hartford Railway is one of the shortest of its members, extending seven miles, from Old Colony House Station, on the Old Colony Road, to Pemberton, the last station on the peninsula whose Atlantic side forms the popular Boston seaside resort known as Nantasket Beach. The Nantasket branch is composed of two natural divisions, the first, about two miles long, runs seaward from Old Colony House to Nantasket Station and Steamboat Landing, where excursionists from Rowe's Wharf, Boston, are landed; the second natural division is from Nantasket Station to Pemberton, at the northern end of the peninsula. From Old Colony House to Nantasket the line runs through two miles of uninhabited sand and rock and salt marsh, and crosses a wide stretch of shallow tide water on trestle work; from Nantasket to Pemberton the beach is thickly built with summer cottages, of pleasing variety, and carries a very large resident population during the season, which is added to enormously by transient visitors from the city during the heated term. Under these conditions it is evident that the passenger traffic of the Nantasket branch might be something quite respectable in point of numbers of a warm summer's day, and also that it is a comparatively incidental and unimportant member of the large system of railway lines controlled by the New York, New Haven & Hartford management. But this branch is just now attracting attention out of all proportion to its importance, merely as a railroad, because upon it has been placed an electric installation, which bids fair to go far toward helping to decide just what proportion of our railroad traffic is to be propelled by power derived from coal burned under stationary instead of under moving steam boilers.

This is not the first instance in which seaside trains have been moved by use of the trolley, but it is the first in which the motors and cars have been of such size and weight and power as to approach the conditions of ordinary railway traffic; previous lines, like those between Brooklyn and Coney Island, have been merely makeshifts, where light cars of the street electric railway pattern were substituted for the previous light and poor passenger trains drawn by steam locomotives. The Twelfth street trolley line of Chicago, while it has a fine iron superstructure, carrying one of the best, if not the very best elevated railway equipments ever constructed, does not at all meet the problems of surface railroading; and the change of the Chicago Lake Street Elevated Traction System from the use of steam locomotives to the employment of the wire and trolley pole, and the affirmed and denied and sure to come displacement of the locomotive by the trolley on the New York City elevated roads, while deeply significant, are not, in view of their limitations, a direct menace to the reign of the steam locomotive.

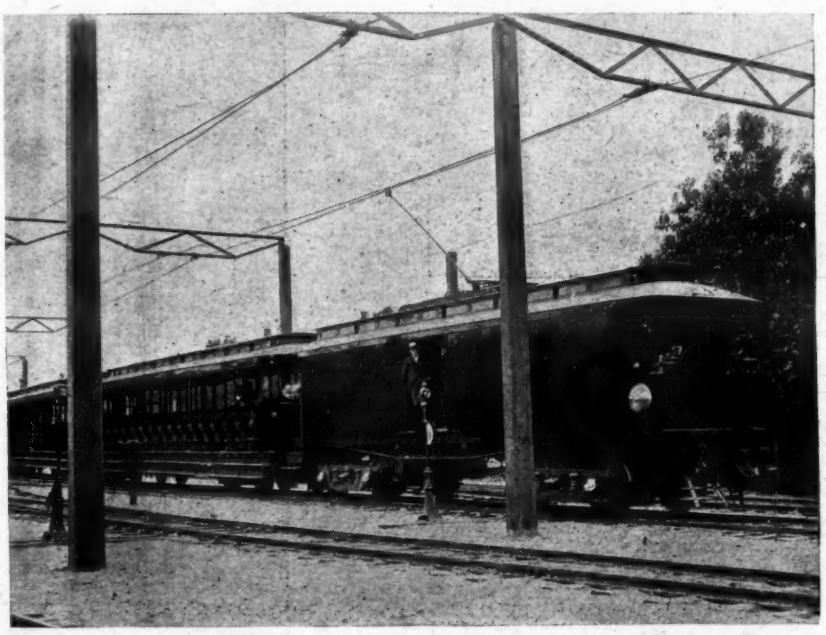


Fig. 13.

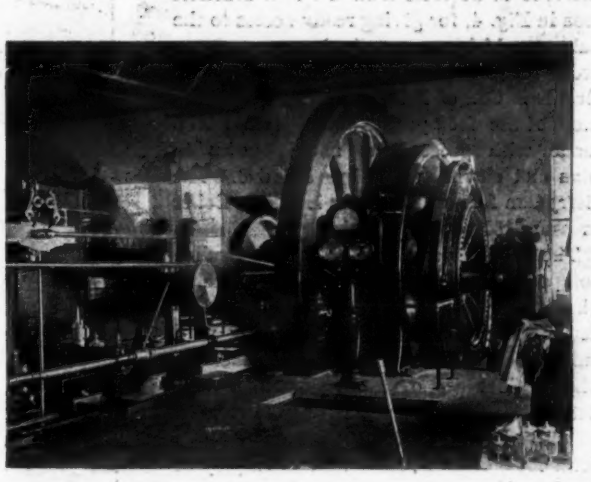
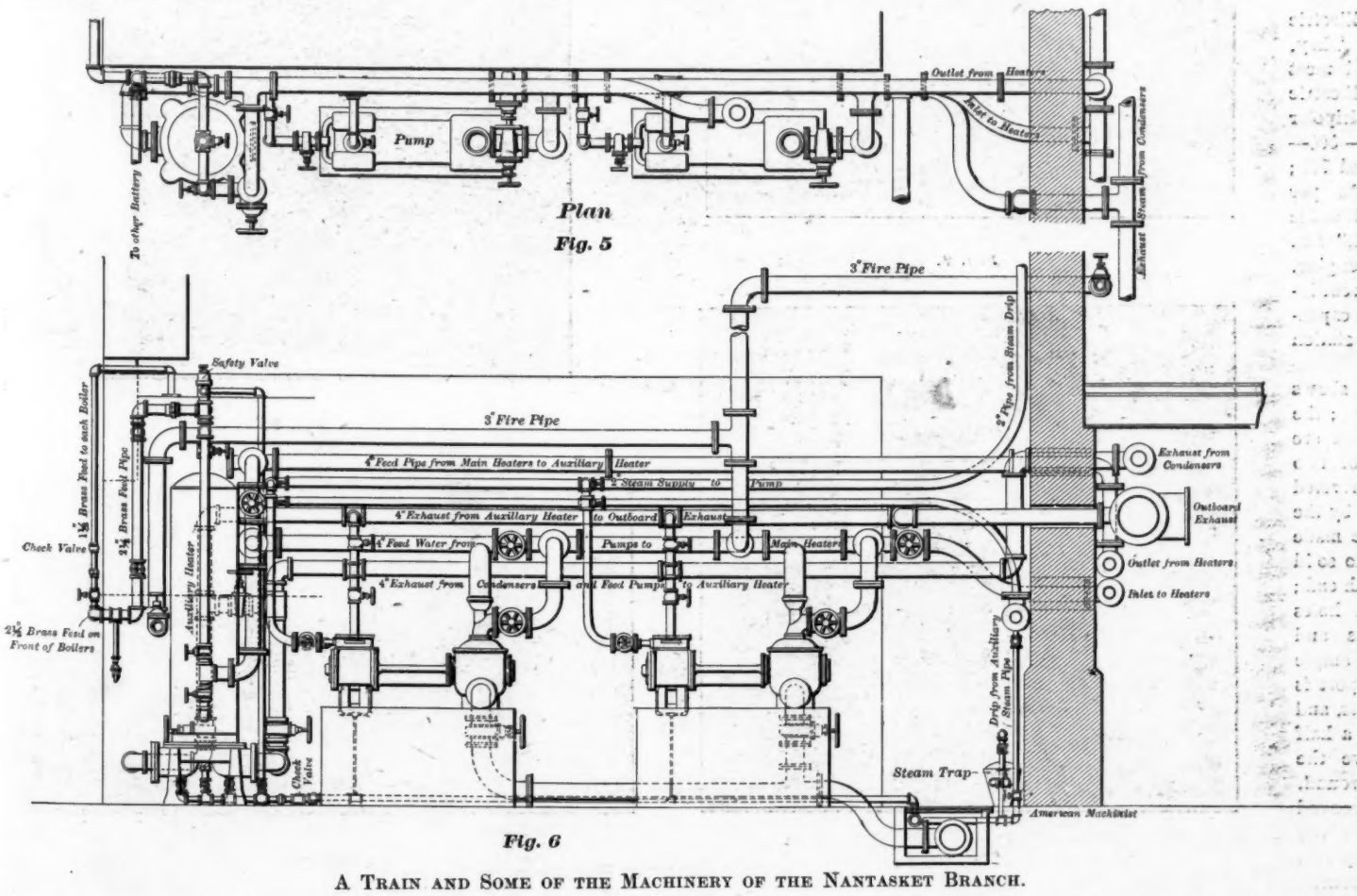


Fig. 8.



A TRAIN AND SOME OF THE MACHINERY OF THE NANTASKET BRANCH.

All previous changes in elevated and suburban surface traction plants have been justly regarded as mere suggestive indications of the trend of practice. Each one involved conditions and agencies differing materially from the circumstances and demands of ordinary railway traffic. But in the Nantasket branch a determined effort has been made for the first time, to lay down such a plant as would prove capable of meeting all conditions of regular railway service, both freight and passenger. There is, as yet, no substitute for the steam boiler; no device for the direct production of electricity by burning coal, so far produced, gives any encouraging promise of final success; the discovery needed to make a direct production of the electric current from combustion may be made at any time, and the steam boiler may some day become obsolete, but that day has not yet come. The steam boiler is retained on the Nantasket branch, and as nothing has been spared to make the entire equipment as nearly as possible perfect, it is worth while to give some attention to the steam-generating plant, as an example of the latest practice. Half way between Old Colony House and Nantasket, beside the tide water in the salt marsh, stands the power house, shown in Fig. 1, 110x83 feet on the ground and 53 feet to peak of roof; the chimney is 115 feet high, 18 feet diameter at base, and it

may be mentioned that this chimney was finished in eleven days after the first brick was laid. A 24-inch wall separates the engine and boiler rooms. The boilers (by Edward Kendall & Sons, Cambridgeport) horizontal flue type, cylindrical shells, are 8 in number, in two banks of four each, 72 inches diameter by 19 feet long, and have ½-inch steel shells with $\frac{9}{16}$ inch heads, and 140 3-inch tubes. The heads are braced by five 1¼-inch wrought-iron braces. The boiler fronts are shown in Fig. 2, and a partial view of the piping, and of the pumps located between the two banks of boilers in Fig. 3. The piping is very fine, brass water tubes being used for all the front work, and was done by the Carman Thompson Co., of Lewiston, Maine.

It will be noticed in Fig. 2 that the fire doors are very far below the boilers; it is 48 inches from the grates to the fire sheet, and the bridge wall is only 18 inches high, thus leaving 30 inches clear between the shell and wall top. This gives a far greater combustion space between the fire and the boilers than is common practice. The boilers are suspended each with four 1½-inch hanging bolts from four pairs of channel bars reaching from wall to wall of each bank of boilers, as shown in Fig. 4, which gives a view of the top of the boilers and the curved copper pipes which carry the steam from the boilers to the overhead distributing pipe; a foot board, not yet in place, is to be carried on the iron brackets seen in Fig. 4, for giving ready access to the valves, which are usually heavy, made to order for this plant by the Eaton, Cole & Burnham Co., of Bridgeport. The arrangement of the feed pumps and pipes has been made with great care, and is shown in plan and elevation in Figs. 5 and 6. The Berryman feed-water heater is used. Boiler pressure 130 pounds.

The engine room contains two tandem compounds, cylinders 20 inches and 88 inches diameter by 48 inches stroke, by the Providence Steam Engine Company, fitted with independent "Deane" pump and condenser. The engines are of the well-known drop flat valve type, operated by the release action, shown in Fig. 7, under charge of John Meadowcroft, long in the employ of the Providence Steam Engine Company, as erecter, but who now leaves that service to take charge of this steam plant.

The dynamos are by the General Electric Co., direct coupled, shown in Fig. 8. They, of course, involve all the latest and most approved practice of the General Electric Co., and are their well-known multipolar generators, "Type M P, Class 10—500—110"; volts, no load 600, full load 700; amperes 715, speed 110 revolutions per minute. The switch board, General Electric Co., shown in Fig. 9, is "Form K," and has two sets of works, one for each engine, capacity 1,000 amperes each, two current indicators, Thompson-Houston system, capacity 1,500 amperes each, and a Weston station ammeter.

The track of the Nantasket branch shows no peculiarities to the casual observer; the "bond" connecting the rails, which are entirely above ground, being made of two flexible copper bonds 7 inches long, riveted to adjacent rail ends and concealed by the fish plates. These flexible bonds are made of copper cables, silver soldered into solid copper plugs $\frac{9}{16}$ inch diameter at each end; these solid copper ends fit $\frac{9}{16}$-inch holes drilled and reamed in the rail ends, and have a very large current capacity, ample for any contingency. The wire support is by wooden posts, 12″x14″ at the butt, and 10″x12″ at the top, with an inch and a half chamfer from a point 5 feet above the ground, to the top, 24 feet from the ground. On top of the post is an iron cap, grooved for five wires; 10 or 12 inches below the cap is an iron cross bar, supported by two brace and current wires, which are secured in the middle to the pole cap; the cross bars carry the trolley wires at their outer ends, 15 feet center to center. This arrangement carries the current direct from the post cap to the cross bar, without cutting in feeder connections, and insures uniformity of current at all points. The setting of these wooden posts consists of a wooden caisson 5 feet deep by 36 inches square, set in the ground, the pole foot placed inside the caisson, and the inside filled with concrete; this gives stability enough to render guy wires needless.

At terminal stations is a system of "run-around" switches, designed by President Clark, by means of which the motor can be detached and quickly run around to the other end of the train. Colonel Heft has designed and put in place a new device in the way of overhead trolley switch and frog with movable point, the whole operated from the ground or from a switch tower in connection with the track switches, so that the motor can be switched or "shunted" precisely as a steam locomotive would be handled; these frogs are suspended from light steel frames supported on wooden posts, as shown in Fig. 10, which is a general view of the terminal work at Pemberton.

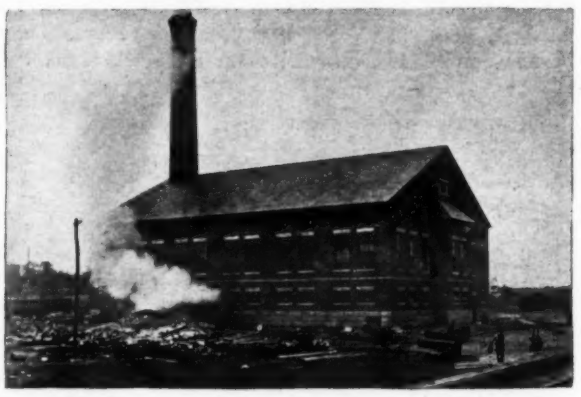


Fig. 1.

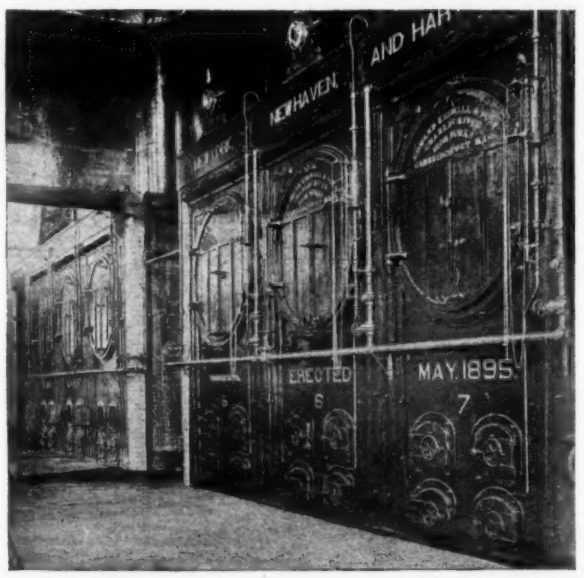


Fig. 2.

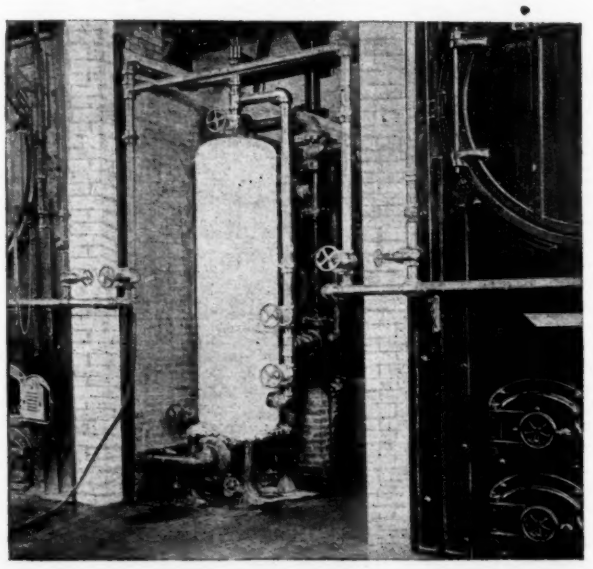


Fig. 3.

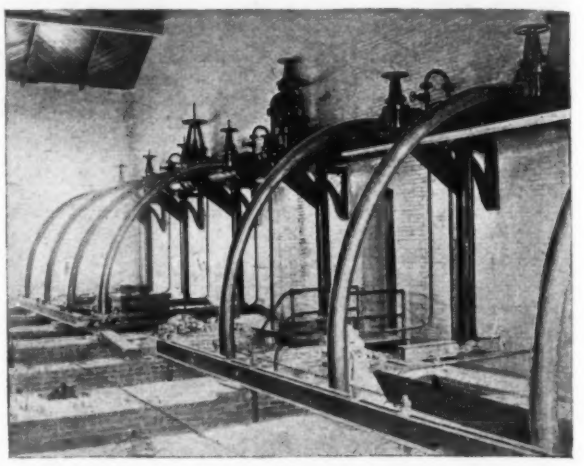


Fig. 4.

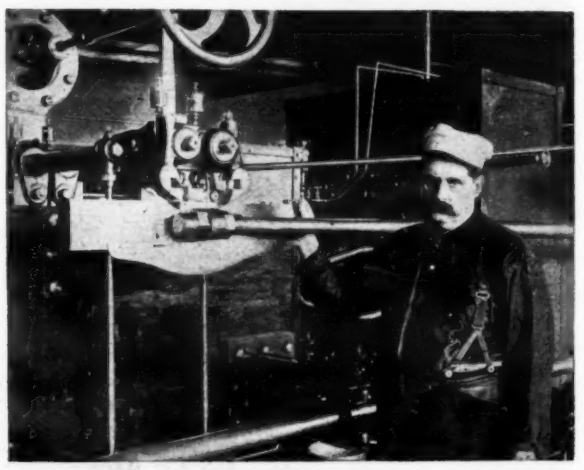


Fig. 7.

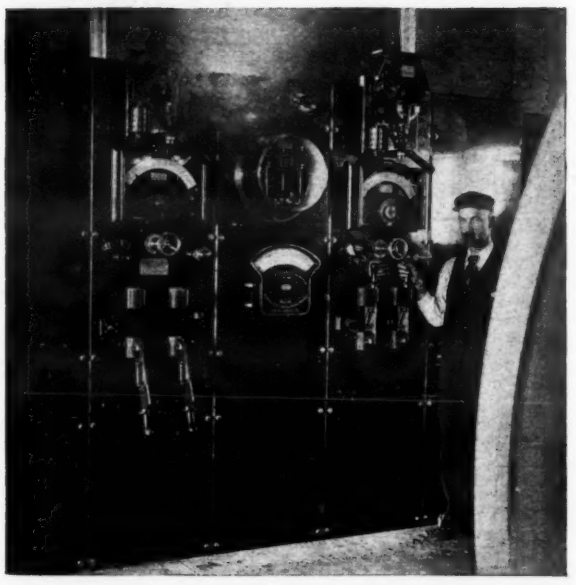


Fig. 9.

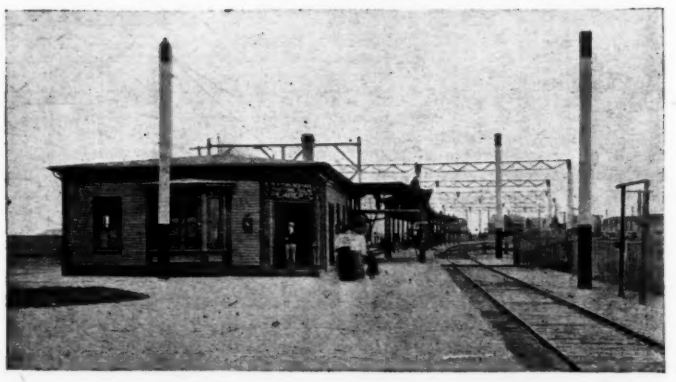


Fig. 10.

AN ELECTRIC RAILROAD.

The "baggage cars," as the motors on the Nantasket branch are nicknamed from their general outward resemblance to the ordinary baggage car, are of two classes, the lighter weighing 19 tons and having 8 wheels, 4 of which are motor driven by motors geared to two of the axles; the heavier weigh 26 tons, all on the 8 drivers, which are all driven by motors on each of the 4 axles. Each motor is individually 103 horse-power nominal; hence the lighter 2-motor class rate at 206 horse-power, while the heavier class have 412 horse-power nominal; really, the full powered 4-motor "baggage cars" can exert from 500 to 550 horse-power; exactly how much is not yet known. The heavier class has $\frac{26}{8} = 3\frac{1}{4}$ tons on each of its 8 drivers 36 inches diameter. The lighter class has $\frac{19 \text{ tons}}{2 \times 4} = 2\frac{3}{8}$ tons on each of four 36-inch drivers. The heavier 8 driver class starts instantly, and can rise to a very high speed so rapidly as to make it convenient for passengers to stay at the rear inside end of the motor; the 4-driver class does not work with such vicious promptness, but is much swifter than anyone has any use for if urged. There is no difficulty in reaching any desired speed in any desired distance, however short, except the awkward tendency of inside passengers to become glued, as it were, to the rear inside wall of the motor; a series of trials showed speeds variously estimated at 75 to 85 miles per hour, the runs being only 3 miles long from start to stop. These trials were made between Nantasket and Pemberton, with "single equipment" motors, having four 36-inch

driven wheels; total weight 19 tons, June 21, 1895.

It might be naturally expected that 250 horse-power would drive a 19-ton motor at almost any speed, so the speed test is not so surprising as the haulage test made June 25, 1895, over the 2-mile stretch of track from Nantasket to Old Colony House. This includes the up-grade curve shown in Fig. 1, between the power house and Nantasket station. Standing on this curve, with 16 ordinary freight cars, carrying 450 tons of freight, in front of her, a 26-ton "double equipment" motor, eight 36-inch drivers, all driven, started very gently, squeezed the train up tight and then started it on this up-grade curve without the slightest shock or the least indication of exertion; experienced railroad men present called it no load at all for the motive power, and believed the "double equipment," though only 26 tons total weight, could easily have handled double the train. The foregoing trials were merely tentative—nothing more than exhibitions; indeed, there have been no tests, proper, made, and no records of performance taken; only one engine was in place in the power house.

The train signal system is pneumatic, furnished by 80 pounds air pressure automatically maintained by a motor-driven air compressor located in one corner of the motor car, and shown in Fig. 12. This air pressure is piped to a large chime whistle for general signals, and to small guard's whistles, or motorman's whistles on the platforms, of usual construction and bell cord connections.

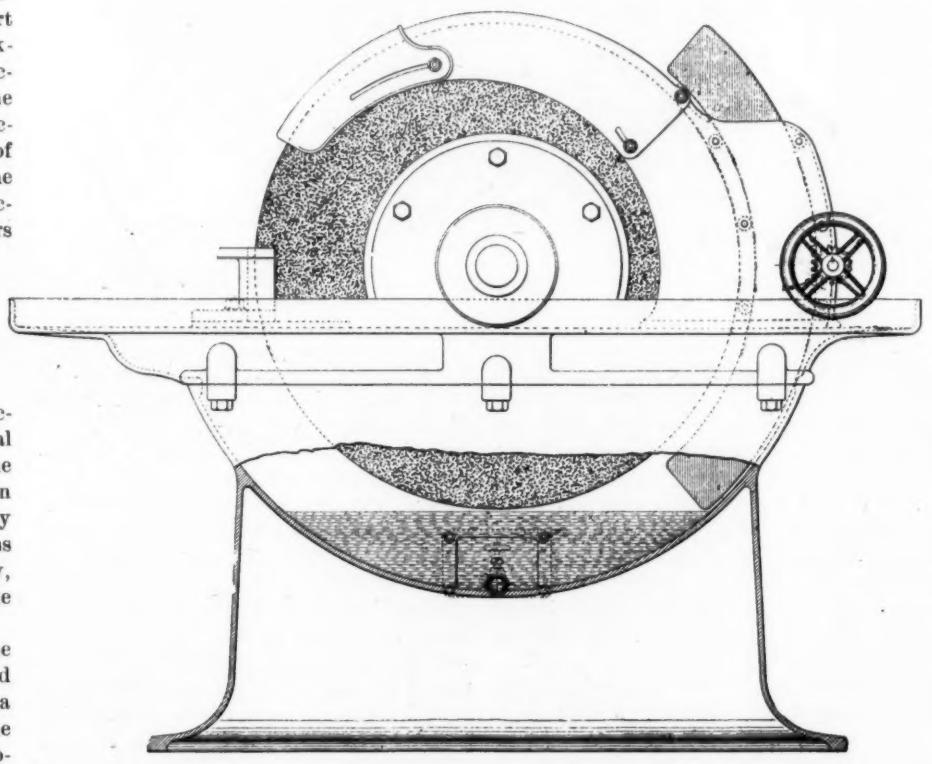
The location of the New York, New Haven & Hartford road takes it through many considerable towns with a restless Yankee populace who are forever taking short journeys. Local companies have found it profitable to parallel considerable stretches of the steam road's tracks with trolley systems, and have by this means diverted a noticeable proportion of the steam road's passenger traffic to their own more frequent service. This is, perhaps, one reason why this steam road has now equipped the Nantasket Branch with such an electric plant as will enable conclusive deductions as to the economy of electric translation to be drawn, but is not the sole reason.

In 1893, President Clark advocated electric traction for surface roads in a report from the board of directors to the stockholders, and his position on the electric traction question found a strong advocate in the person of Judge John M. Hall, upon the accession of that gentleman to the position of vice-president and general manager of the New Haven & Hartford system. The electrical committee of the board of directors was made up of Chas. P. Clark, president, Judge Jno. M. Hall, vice-president, and Chas. F. Brooker, director. All of these gentlemen in the course of their investigations became ardent advocates of electric traction. The services of Col. N. H. Heft, of Bridgeport, were called in as electrical expert and constructor. What the final decision will be is a matter of no doubt in the minds of Judge Hall and Colonel Heft. In Colonel Heft's opinion, the overhead trolley system will not be the final form. He leans to the central rail distribution of electricity, including of course, the abolition of the grade crossing.

Whatever the verdict may be, it is of the very greatest interest to all mechanics and engineers especially. Somewhere there is a line which divides the proper field of the electric motor from that of the steam locomotive. The exact position of this line is at present not known, but the above described installation will help to locate it.

A New Tool Grinder.

The accompanying engraving illustrates a new tool grinder recently brought out by the Appleton Mfg. Co., Philadelphia. The principal feature of the machine consists in the method of applying water to the wheel. Back of the rear wall of the hood encasing the upper part of the wheel is an opening through which the curved piece shown passes between rollers for easy movement, and is operated by hand wheel, rack and pinion. A downward movement of it displaces the water and raises its level to any point of immersion of the under portion of the wheel; the water is then picked up by the wheel and carried over in any desired quantity to the point of delivery in front, and is poured onto the tool. A turn of the hand wheel in the opposite direction withdraws the piece, the water recedes and the wheel becomes dry. A reservoir of ample capacity is cast in the base, the bottom of it being of a shape to incline the grindings to the point of outlet for which a large brass cock is provided, also a hand-hole plate, if required for cleaning. The machine is unusually free from slop and untidiness; is accessible, easily cleaned and free from trouble incident to the use of pumps, tanks, etc.; the liability to get out of order being reduced to a minimum. It is made for wheels 24, 30 and 36 inches and of varying thickness.



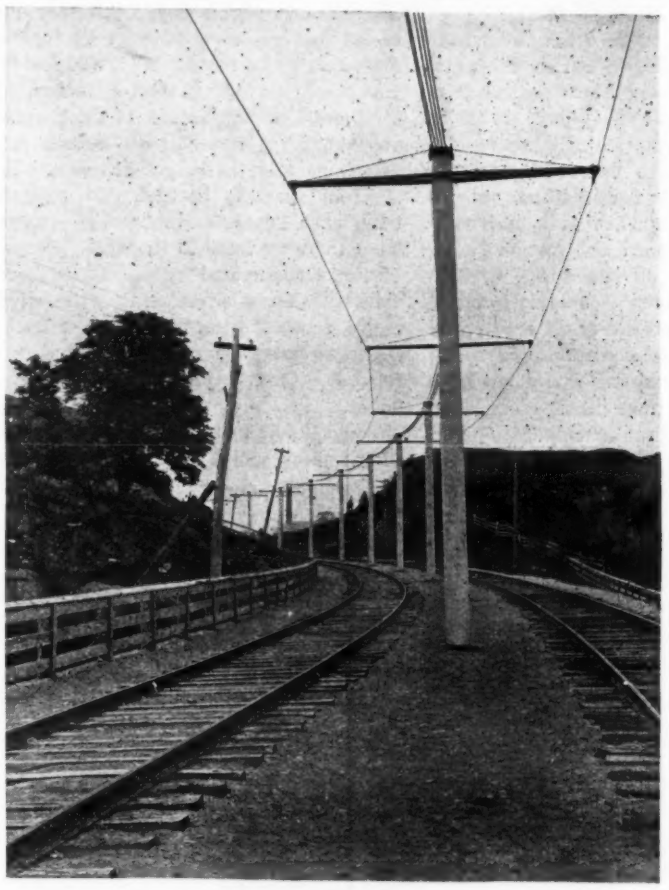
A NEW TOOL GRINDER.

A street railway in San Francisco draws sea water five miles for condensing, and the warm water is then used in a bathing establishment near the power house.

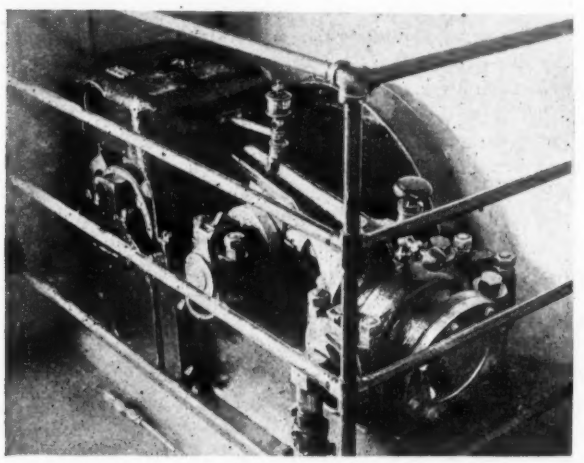
Long Distance Electric Power Transmission.

Sacramento, Cal., is now receiving electric power transmitted from the falls of the American River at Folsom. The distance of transmission is 24 miles, and the first practical operation of the plant occurred on July 15th. The electric current will be used in Sacramento for street railways, lighting, driving factories, and for domestic cooking. The water power plant has been some years in construction, an immense masonry dam having been constructed forming a reservoir capable of maintaining a flow of 85,000 cubic feet of water per minute. The power is developed by four horizontal shaft double turbines, and the water is afterwards used for irrigation.

The turbine wheels, 30 inches in diameter, with 55 feet head, develop 1,300 horse power each. The shafts of the water wheels are coupled direct to four three-phase alternating current generators capable of generating 1,000 horse-power each. The current passes through "step-up" transformers raising the voltage to 10,000, and it is transmitted by overhead copper wires to the city. The loss in line transmission is estimated at 20 per cent. The use of larger conductors would, of course, reduce this loss, but as there is a large surplus of power they are not now necessary.



AN ELECTRIC ROAD.—FIG. 11.



ELECTRICALLY DRIVEN COMPRESSOR.—FIG. 12.

Information About the Engines of the "St. Louis."

Our article regarding the steamship "St. Louis" has been criticised by some of our friends as not being up to our usual standard in such matters. Regarding this, all we can say is that we were fully aware of this fact, and would not, under the circumstances, have devoted so much space to, nor, in fact, any space whatever, had we not thought that our readers would be especially interested in this vessel, because of the peculiar circumstances connected with its construction.

We were not able to give at the time even the commonest facts regarding the engines, such as the stroke, kind of valves used, size of shafts, etc. Of course we made an effort to obtain at least the leading points of information, believing that such facts and much more would, in a short time, be in possession of most establishments building similar engines, and that the publication would therefore do no harm, while it would in other ways do good. Messrs. Cramp did not take this view of the case, however, and the information we could obtain from them was so meager that, ordinarily, we should not have considered it worth while to publish anything regarding the vessel, and would not have done so except for the exceptional circumstances mentioned above.

Our London contemporary, *Engineering*, seems, however, to have been more successful in securing information regarding this "American vessel, made entirely of American materials, and by American skill and labor." Of course much of this information is inferable from our previously published engravings. No American journal, so far as we are aware, was able to secure more definite information than that the boilers were "enormous," etc. We quote from our English contemporary as follows:

"The main engines are of the quadruple-expansion type, with six cylinders working on four cranks, an arrangement patented by Mr John Thom, who is associated with the technical staff of the American line as a consulting engineer. There are two high-pressure cylinders, and each of these is placed over one of the two low-pressure cylinders. The tandem cylinders are at the forward end, the arrangement being high pressure and low pressure working on the first crank, the same working on the second crank, the second intermediate on the third crank, and the first intermediate on the fourth crank. The diameters of the respective cylinders are: two high pressure, 28½ inches; first intermediate, 55 inches; second intermediate, 77 inches; two low pressure, 77 inches. The stroke in each case is 5 feet. The cylinders are each separate castings, and are supported on A-frames at back and front, the condenser and its pumps being separate and placed in the wings of the ship. The supporting frames are cast in two parts, each part having three sides only, with flanges to the outside for bolting together. The inside is thus entirely open, so that the soundness of the casting is apparent. The cylinders are braced longitudinally by cast-iron girders of box section, which also extend between the forward and

aft cylinder and the ship's bulkhead, so that there is little tendency to work. These bulkheads are specially stiffened by girders 2 feet deep, built of plates and angle bars. Each high-pressure cylinder is carried 24 inches above the low-pressure cylinder on cast-iron frames on either side, and this clearance enables a manhole to be provided on the top of the low-pressure cylinder to admit of examination, etc. The main stop valve is in the engine room, on the same level as the high-pressure cylinders; and the inlet to the high-pressure cylinder valves is controlled by a balanced piston throttle valve on the main pipe. The steam pipes, it may be said, are all of steel, lap welded, with double-riveted flanges, and the largest is 20 inches in diameter.

"Piston valves of the Thom's balanced type are fitted throughout, and they are operated by the usual double-eccentric link motion, the bent rod being for the astern motion. There are two valves for the low-pressure cylinders. The spindle of the high-pressure cylinder valve is worked from the low-pressure valve crosshead through a bell-crank lever.

"The second intermediate and the two low-pressure cylinders only have jackets, and these drain into water taps which discharge into the hot well tank. Outside all the cylinders are coated with asbestos, hair felt, and covered with sheet steel. Cramp's metallic packing is used throughout. It is somewhat similar to the United States packing, with cast-iron rings compressed by a spiral spring. The clearance in the cylinders is on the top of the pistons $\frac{1}{4}$ inch, and below, $\frac{5}{8}$ inch. The piston rods of the high-pressure cylinders are 6 inches in diameter, and in the other cylinders $8\frac{1}{2}$ inches. The connecting rod is fully twice the length of stroke, 11 feet 3 inches centers, and it is $8\frac{1}{2}$ inches in diameter at top, and 10 inches at bottom. The connecting rod at top is not forged with the usual U-end for the cross-head pins. The crosshead connection is built up. The top of the rod is squared to a T-piece, with a hole bored through the two heads. On the bottom of the crosshead itself, at either side, there is a forged projection, which is screwed and passed through the holes and bolted. In other words, the crosshead brasses have a steel T-piece with pin forged to the bottom which passes through the holes on the top of the connecting rod. Slipper guides for the crosshead are fitted to each side of the framing. There is a steel flange fitted on either side of the column face, and the slipper works inside it. Between the back of the crosshead and the other frame there is a small gangway to admit of inspection, and to economize weight a hole is bored through the crosshead brasses, which also have the usual piece for adjustment.

"The crank shaft is 21 inches in diameter, the crank pins 22 inches, the bolts being 5 inches at the bottom of the thread. The cranks themselves are 16 inches broad, the length of pin being $31\frac{1}{4}$ inches, and there is a 6-inch hole through the cranks and pins. The bearings are 26 inches long, and are of cast steel filled with Parson's metal. They are bolted down with $4\frac{1}{2}$-inch bolts, and in the bottom water is circulated. Here it may be stated that the bed-plate is of cast-iron box section, 3 feet 4 inches deep, and 4 feet 7 inches at the center, the center part, instead of being flat, being dished to the extent of 1 foot. The bases of the standards are fitted to the dished part of the bed-plate as well as the flat portion, so as to tend to obviate the radial 'working' which sets up torsional vibration and strains.

"The thrust shaft is 21 inches in diameter, and solid, the diameter over thrust rings being 33 inches. There are 13 horseshoe collars, each $2\frac{1}{2}$ inches thick, and the surface on the ahead side is 6,616 square inches. The length of the thrust shaft is 14 feet, and it is secured to the bed-plate of the engines. The horseshoe rings are adjustable by a horizontal screw with two nuts for each side, which greatly facilitates the removal of any ring. The turning wheel is immediately aft of the thrust shaft. The engine has two cylinders, 8 inches in diameter by 8 inches stroke. The thrust shaft, by the way, is placed in a recess, and over it, with entrance from an upper platform, is the dynamo room.

"The propeller or line shaft is 19 inches in diameter, also solid. It is fitted in lengths of 23 feet, with bearings 14 feet apart. These bearings are 2 feet long, and have cast-steel bobies, filled with Parson's white metal. There is fitted to the after length of the shaft a portable coupling. It is in halves, and through each half there is a longitudinal feather 5 inches wide and $2\frac{1}{4}$ inches deep. The ten bolts were put through the coupling when at a high temperature, the subsequent contraction giving greater binding to obviate slip. This arrangement, which is not usual, is to facilitate the drawing of the shaft for repair. The feathers running longitudinally through each half of the coupling would not have prevented the shaft from backing out when the engine was going astern, and to overcome this possibility, grooves 1 inch deep were turned in the shaft, forming collars, which engage in collars and grooves on the coupling. There is no outboard shaft, the framing and plating of the ship being bossed out in the same way as in most high-speed twin-screw merchant steamers now. The stern shaft, which is 21 inches in diameter, is covered with a liner $1\frac{1}{2}$ inches, working in lignum-vitæ bearings, constructed in the old style in strips $3\frac{1}{2}$ inches broad and 1 inch deep, the division between the strips allowing water to circulate. The stern gland is light, but is packed with Tupper's machine plaited flax packing. The bosses of the propellers are of steel, with three blades of Parson's bronze, and these, for the present, are set at a pitch of $27\frac{1}{2}$ feet.

"The condensers are, as we have already stated, separate from the main engines. They are 7 feet 2 inches inside diameter, and the tubes, which are of seamless brass, are $\frac{3}{4}$ inch in diameter and 16 feet $8\frac{5}{8}$ inches long. There are six stay rods, and the tubes are supported at two intermediate points between the tube plates. The total condensing surface is 26,170 square feet. The air pumps are also placed in the wings of the ship. There are four for each condenser, and they are of the Worthington type, with steam cylinders 26 inches in diameter and 20 inches stroke. There are 8-inch valves to each of the four buckets.

"We come now to the boilers, which work at 200 pounds pressure, having been tested to 300 pounds by water pressure. There are six double-ended and four single-ended boilers, each 15 feet $7\frac{1}{2}$ inches in diameter, while the former are 20 feet long, and the latter are 10 feet $4\frac{1}{2}$ inches. The shell plates are $1\frac{9}{16}$ inches in thickness, and are quadruple riveted with $1\frac{1}{4}$-inch rivets. The front plate is flanged inwards. There are four furnaces in each end, and these have each separate combustion chambers. Thus there are in all 64 furnaces. These are of Fox's corrugated type, and in accordance with latest practice they are slightly reduced in diameter towards the back, so that they may be readily withdrawn for repairs without injuring the front of the boiler. The flues are 3 feet 3 inches in diameter, of $\frac{19}{32}$ inch thickness of metal, and the furnaces, which have ordinary fire bars, are 6 feet $10\frac{1}{2}$ inches long. There are 416 tubes in the single-ended, and 832 in the double ended boilers, the total number of tubes in all boilers being 6,656. The number of stay tubes is 328 in each double-ended boiler. The fire tubes are $2\frac{1}{4}$ inches in external diameter, and the thickness of metal 11 B. W. G., while the stay tubes are $2\frac{1}{4}$ inches in diameter and $\frac{1}{4}$ inch thick, the distance between the tube sheets being 7 feet. The tubes, by the way, are fitted with spiral retarders which have given good results in causing the hot gases to pass in a helical course through the tubes, and thus insure prolonged contact with the surface. The tube plates are $\frac{5}{8}$ inch thick. The diameter of the combustion chamber stays at the smallest base is $1\frac{1}{4}$ inches for the outside row, and $1\frac{5}{8}$ inches for the inside row, by 7 inches pitch. The total grate area is 1,144 square feet, and the total heating surface 40,320 square feet. There are six safety valves on the double-ended, and four on the single-ended boilers, all of 4 inches diameter.

"The installation of boilers is equally divided between two water-tight compartments. There are thus three double-ended and two single-ended boilers in each, and the installation is worked under Howden's system of forced draught, by which the air is heated before being passed into the furnace. The stokehold is open, and is specially well ventilated. It is divided longitudinally in the middle line by a thin plating or screen, which comes to within 6 feet of the heads of the stokers. The down air shaft is on the one side of this screen, and the other side is closed in at the top, excepting the in-take for the forced draught fans. Thus the current of air is brought as near the stoking floor as possible. There is bunker capacity for carrying 2,500 tons of coal, which will just equal eight days' consumption."

In reference to the above, *Engineering* of July 5th publishes a note from Jno. Thom, M. I. N. A., in which he says:

"In reference to your description of the 'St. Louis,' now appearing in *Engineering*, my patent quadruple-expansion engine is arranged only for four cylinders; the six-cylinder arrangement is Messrs. Cramp's design entirely."

Improved Thirty-inch Shaper.

We present herewith an illustration of an improved form of the shaper built by The Fox Machine Co., of Grand Rapids, Mich.

In this machine the support for the ram is extended out over the table to give rigidity during the cut, and on this account the slide is placed at the side of the ram instead of beneath it.

The stroke of the machine is 30 inches, and for the traverse of the work (feed motion) a slide is placed on top of the knee, neither the knee nor the ram having any lateral motion.

The nut for the elevating screw is raised sufficiently to make it unnecessary to cut a hole in the floor for the screw to pass through.

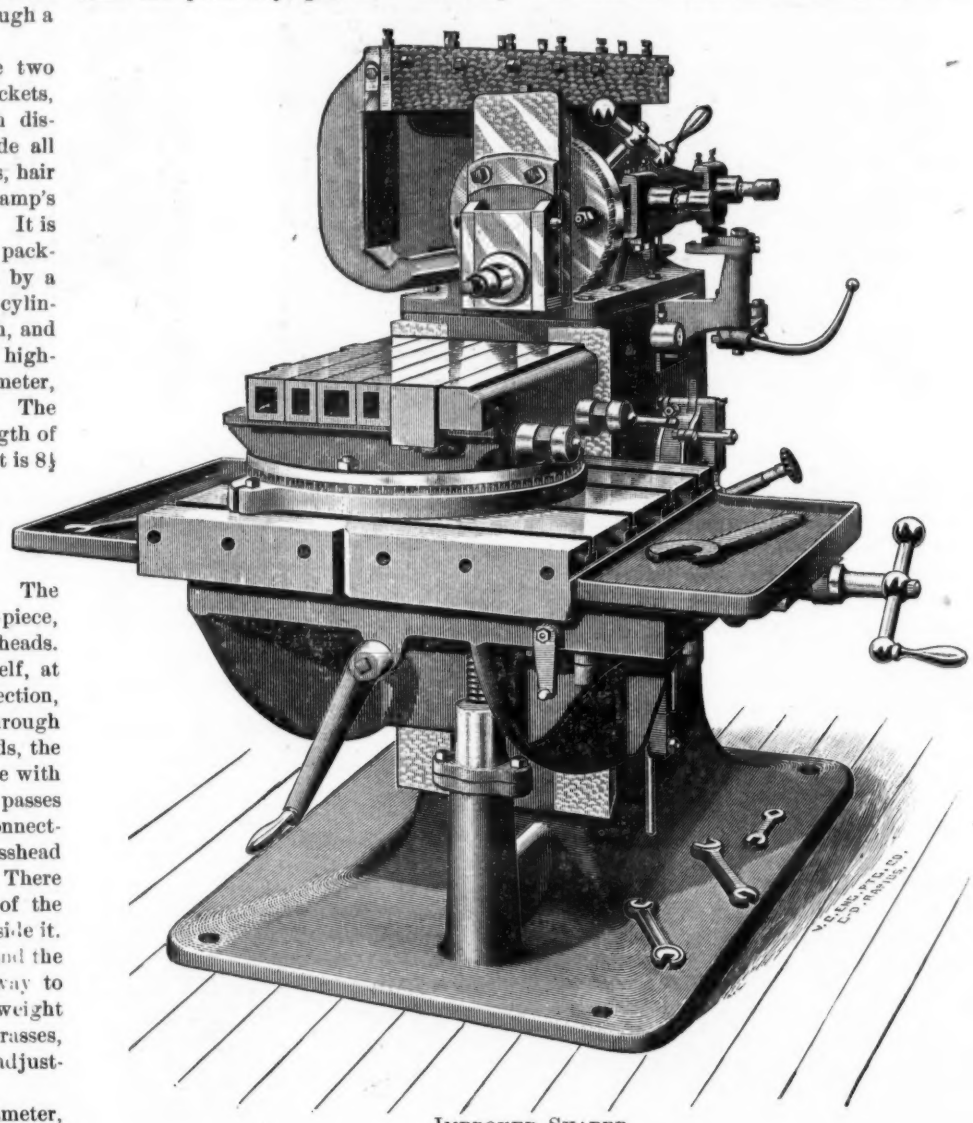
The ram is moved by rack and gearing, giving a uniform cutting speed at all strokes and pulleys are arranged to give a very quick return stroke.

The housing which supports the ram extends out over the table 16 inches, so that when the ram is out to a stroke of 24 inches it is just flush with the end of the housing, the total length of which is 48 inches. The length of the ram is 34 inches.

Special pains have been taken to so arrange things that an accurate cut can be taken the entire length of the stroke.

The elevating screw is $1\frac{1}{16}$ inches diameter and is set just outside the center of gravity of the table. The table is 40 inches long and has a bearing of 26 inches on the knee. The planed surface on top is 24 inches square, and has a vertical adjustment of 16 inches.

The machine as shown weighs about 3,500 pounds.



IMPROVED SHAPER.

Experiments With Foundry Iron and Aluminum.

MADE BY C. G. TAYLOR, SUPERINTENDENT OF SHOPS, UNIVERSITY OF MICHIGAN.

Aluminum in cast-iron is an alloy which has been much considered, and some extravagant statements have been made in its favor by certain unscrupulous manufacturers.

Mr. Keep, Superintendent of the Michigan Stove Company, of Detroit, has done some elaborate work in this line, and has come to the conclusion that it is of little benefit to use aluminum in cast-iron. He is convinced, however, that the hard irons will stand more aluminum than the soft irons, and that aluminum possesses the power to a great extent to change combined carbon into graphite.

Wishing to know what effect aluminum does have on cast-iron, I made some experiments with a view of ascertaining the effect of aluminum when added to cast-iron in a commercial way in the foundry. After some months' experimenting, the conclusion was reached that some of the manufacturers either do not test their iron, or have been deceiving the public.

Making the Test Bars.—The bars were eighteen inches long by one inch square, enlarged at the ends to fit the testing machine. The bars were molded in green sand, and cast the same as commercial iron, except that they were poured on end to insure sound castings.

The test bars in the table below, which show high results, were made from Scioto No. 1 pig and scrap iron, half and half. The bars that show low results were made from an Ohio iron. The scrap was selected with care, and run about the same all through. The test bars were made at the middle of heats, ranging from twelve to fifteen hundred pounds each. The furnace used was an eighteen-inch plain cupola, in the foundry at the engineering laboratory of the University of Michigan.

All of the odd numbers in the table represent iron, while the even numbers represent iron with aluminum. Every odd and every even number represents an average of three pieces. The links in the table show that both numbers are from the same ladle of iron.

When test bars were made the furnace was tapped, and some of the iron was taken out and cast into the odd numbers. The rest of the iron was run into a ladle, which had been weighted with a known quantity of aluminum at the bottom, to allow the iron to pour over it, thus mixing better than by placing the aluminum in the ladle, and stirring it in from the top. When the iron had filled the ladle, it was weighed, and the ladle deducted. The test bars thus made were allowed to cool slowly in order to be soft.

The pieces which were high in aluminum looked more like lead than iron on the outside; the sand peeled off much smoother than from the castings where aluminum was not used.

One thing was very marked about the iron before it was poured. The ladles which had less than one-half of one per cent. of aluminum were very fluid, while those with over one per cent. were not very fluid. The iron with a small amount of aluminum boiled very freely and cast into fine, sharp work. One can see by the table that for small fine castings a small per cent. of aluminum is of some benefit: (1) It makes the iron more fluid; (2) it makes the castings smoother and sharper; (3) it makes the castings a little stronger.

Cleaning and Measuring.—The pieces were cleaned, but the scale was not removed. The specimens were marked every eight inches, and the cross-section at the marks measured. The elongation was noted, but amounted to but little. The reduction of areas at the break was practically nothing.

Testing.—The testing was done on an Olsen, one hundred thousand-pound testing machine, at the engineering laboratory, University of Michigan.

The elastic limit and the ultimate strength were practically the same.

On examining the table it can readily be seen that if aluminum is to be used at all, it must be in small quantities, or it is more apt to do harm than good. I made some experiments on hard iron, and found that aluminum in percentage ranging from ½ per cent. to 1 per cent. will improve hard iron in many cases and make it much softer.

I have drawn the following conclusions from my own experiments and those of others:

The condition of cast-iron depends largely upon the nature of its carbon. If the iron has too much combined carbon it is apt to be hard and brittle; if it has too much graphite it is apt to be weak. There is a certain mediam point at which we get the greatest strength, therefore aluminum would be beneficial only where the carbon needed freeing. On the other hand, aluminum is detrimental where too much free carbon exists.

We may safely say that aluminum should not be put in the hands of an ordinary foundryman, but if used at all it must be used in a scientific manner.

Aluminum if added at all to cast-iron, should be done during the manufacture of the pig-iron at the blast furnace.

It is generally the opinion that aluminum helps to make sound castings. I found this to be so when small quantities were used.

One reason, however, for not using aluminum in the foundry is this, it makes the slag very brittle. This slag is apt to break away and get into the mold. Aluminum iron does not unite well when two surfaces come together in a mold; this is another reason for not using it for certain classes of work.

In conclusion I may say with Mr. Keep, that aluminum as a rule is not a safe thing to use in the foundry.

Experiments were made with much smaller per cents. of aluminum than is shown in the table, but with but little change to the castings.

Before closing it may be well to state that Mr. Wittenstroem, of Stockholm, working with the co-operation of Mr. S. Nobel, of St. Petersburg, found that if a small amount of aluminum (say 1 per cent.) is added to a crucible of Swede wrought-iron which has been heated until pasty (2,200° Fahr.) the iron immediately liquefies and can be poured into castings, having all the properties of wrought-iron except fiber, and as sound as if of cast-iron.

This idea was investigated thoroughly at Nordenfelt's malleable iron foundry, in Carlwick, Sweden, with perfect success. Four plants have been built in this country for manufacturing this kind of iron. Some two years ago I had the opportunity of visiting one in Massachusetts, and was told that 1 per cent. of aluminum made the iron more fluid at 2,200° Fahr. (which is about the melting point of cast-iron) than it would be without it at 3,500 degrees. This process is known as the Mitis process of making wrought-iron castings.

TABLE OF BREAKING BY DIRECT PULL.

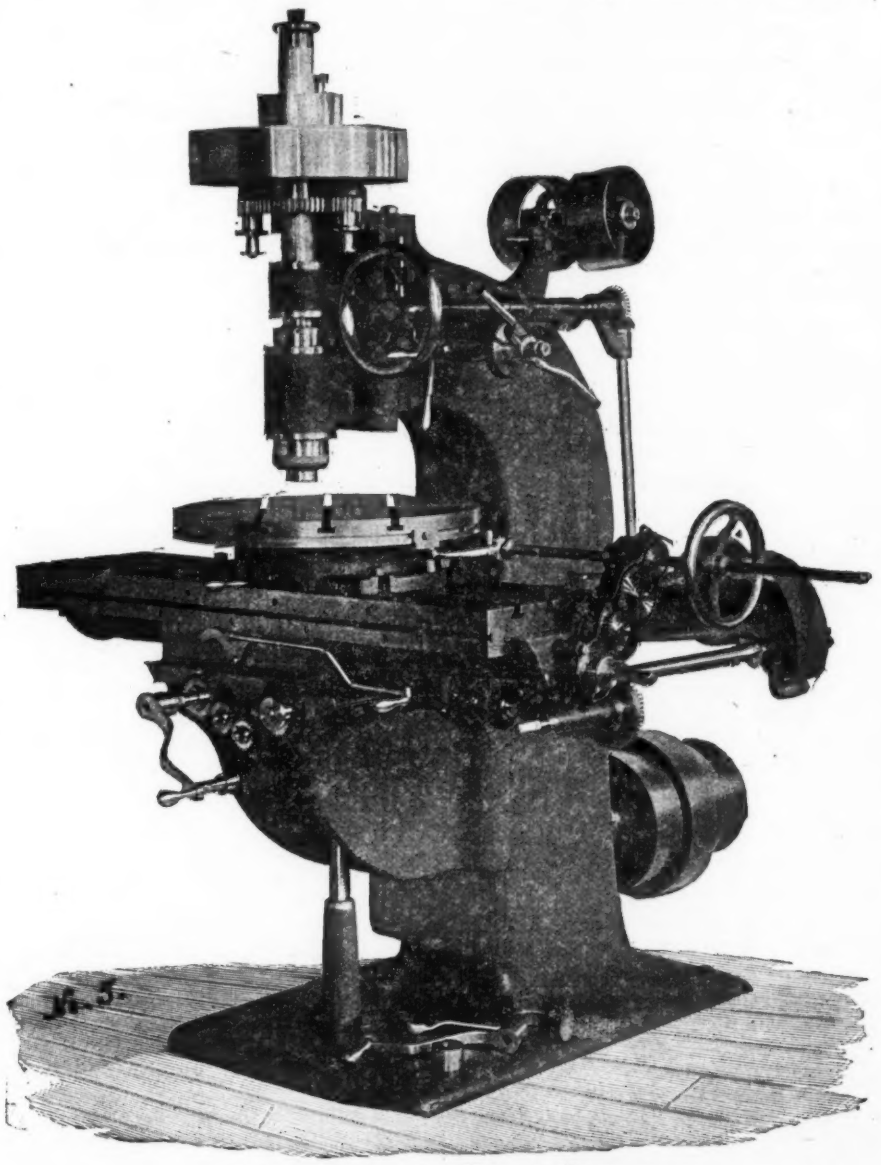
	Number.	Per cent. of Pig Iron.	Per cent. of Scrap iron.	Per cent. of Aluminum.	Per cent. of Elongation.	Sectional Dimension.	Ultimate Strength per Square Inch.	Character of Break.
Scioto. Ohio Iron. Unknown Pig Iron.	1	50	50	....	.01	1.040 x 1 018	13,392	Medium.
	2	49.5	49.5	1	...	1.0026 x 1.005	8,238	Rather coarse.
	3	50	50	....	.01	1.024 x 1 011	14,785	Medium.
	4	49.70	49.70	.60	...	991 x 1.010	12.067	Coarse.
	5	50	50	....	.01	1 004 x .988	14,602	Medium.
	6	49.80	49.80	.40	.01	.996 x .991	12,670	Medium.
	7	50	50	....	.02	.982 x .976	15,808	Medium.
	8	49.85	49.85	.30	.01	.986 x .995	11,063	Rather coarse.
	9	50	50	....	.03	.998 x 1.000	17,835	Medium fine.
	10	49.90	49 90	.20	.01	1.003 x .992	12,667	Medium.
	11	50	50	....	.02	.970 x .983	13,948	Medium.
	12	49.92	49 92	.16	.02	1.010 x .990	12,320	Medium.
	13	50	50	....	.02	.996 x 1.003	13,159	Medium.
	14	49 98	49 98	.04	.01	.998 x 1.004	14,563	Medium.
	15	50	50	....	.02	1 004 x 1.010	12,9.0	Medium.
	16	49 99	49.99	.02	.01	.995 x 1 000	14,820	Medium.
	17	50	50	....	.03	1.040 x 1 025	22,138	Rather fine.
	18	49 995	49.995	.01	.04	1.030 x 1.030	23 882	Medium.
	19	50	50	....	.03	1.025 x 1 030	22,064	Ratner fine.
	20	49.998	49.998	.004	.04	1.022 x 1.024	23,370	Medium.
	21	50	50	....	.02	.999 x 1.024	23,010	Rather fine.
	22	49.998	49.998	.004	.03	1 040 x .995	22,901	Rather fine.

The Becker Vertical Milling Machine.

We present herewith an engraving of an improved vertical spindle milling machine, which, while it is well adapted to lighter work, is provided with double back gears by which the spindle is powerfully driven for heavier work when required, the range of speeds being from 10 to 800 revolutions per minute.

The driving pulley, which is 15″x8½″, is internally back-geared 5 to 1, there being two sets of gears diametrically opposite each other, for the sake of balancing the stresses. The pulley is, however, independently mounted so that belt pull does not affect the spindle, and every precaution is taken to maintain accurate alignment, which, of course, is especially important when large face mills are used.

The main bearing of spindle is 3″ diameter, and thrust bearings at both ends of this box are provided with steel balls. The spindle is bored to the B. & S. taper, unless ordered otherwise. Shanks of end mills are secured by a draw bar which passes through the spindle, and the end of the spindle is threaded for the reception of



COMPOUND VERTICAL MILLING MACHINE.

larger cutters, especially those with inserted teeth.

The head in which the spindle is mounted has a vertical movement of 7″, with automatic feed and stop, making the machine capable of boring or drilling, if desired. The automatic stop is graduated to be set to .001″ for regulating the depth of cut.

The table has a working surface of 48″x 13″, and is fed automatically 40″ in one direction, 13″ in the other.

The rotary attachment, shown in place upon the table, has a circular table 22″ diameter, and is fed automatically in either direction. It also has an automatic stop, and swings 34″ diameter clear of the column.

The feeds are obtained by means of compounded gears giving six changes for each spindle speed.

The knee has a vertical adjustment of 18″, and the greatest distance between table and spindle is 21″; between spindle and rotary table, 15½″.

Vise jaws are furnished which are used in connection with the T-slots in the table. They are 9″x2″, and the amount of opening between them is limited only by the length of the table. An extra arbor support is provided for use when straddle—or gang—milling is done. This bolts to the knee. There is a double-friction countershaft arranged to run at 120 and 400 revolutions. The machine weighs about 4,000 pounds. It is made by the John Becker Mfg. Co., Fitchburg, Mass.

LETTERS FROM PRACTICAL MEN.

A Man Has a Right to His Market.

Editor American Machinist:

I have read the article in your issue of July 11th, entitled "How to Hire Hands." I was glad to see that article, which is not saying that I agree with it, but it opens a subject that most of us have thought about, that we don't generally talk much about, yet which probably it will be well to discuss a little in a frank and friendly way. I do not know whether the letter of "Z" to "X" has any basis of genuineness, but it shows up a delicate subject from the employers' standpoint quite clearly. There is, of course, another side to the question that is here opened, and I happen to stand upon that other side. It has always seemed strange to me that in business the keenest competition is fair and honorable when it relates to the procuring of material, or to the selling of products, or to the securing of contracts, but that in the employment of labor all competition between employers is dishonorable. I think it would puzzle any employer to explain wherein the dishonor consisted.

It is inevitable that the workman should take a lively interest in this subject, for upon it depends the adjustment of his wages, and that is what he works for. If supply and demand are not to determine his wages, in what way are they to be determined? And if demand is to be muzzled and inoperative, is not the dishonor with the one who would suppress the demand rather than with him who would claim the right to express it? I have never learned that any part of the wages paid to a workman for honest work is a free gift to him. The general advances of wages that we are just now all quite glad to be hearing about are not a proof of liberality on the part of the respective employers, but are universally interpreted by the press and

by the people, by employers and employes alike, as a proof of an increasing demand for labor. The demand for labor may affect the price of it both as to quantity and as to quality. It may be unfortunate for the employer that an employe may increase in skill while in his service, and can carry that skill away with him, but it happens to be the fact, and "dishonorable" employers find it out, and it seems to be their practice to take advantage of it. The only safe thing for employers to do in this state of affairs is for them all to be "dishonorable" alike, and have it understood that if they want a man they may feel at liberty to bid for him. A workman should be worth more in the shop where he is thoroughly at home and familiar with the ways of it, then he could be in a strange shop, and the employer can always protect himself by paying enough to retain the man, and still have a decided advantage in the competition. It may be that my views would undergo a radical change the moment that I ceased to be an employe and became an employer; that may be the inevitable, the automatic action of human nature, but just now it seems to me that if I wanted a man who was working for somebody else, and if it was, as it generally is, a question of dollars and cents about getting him, I would feel that I had a perfect right to make him an offer. I would feel that in doing so I was asserting both my own right to bid and the right of the man to receive and entertain the bid. I think that there is seldom any wrong done to anybody when hands are enticed away. It does not apparently tend to depreciate wages, and he would be considered a rather peculiar man who should say that in his opinion mechanics were getting too much.

TECUMSEH SWIFT.

Calipers.

Editor American Machinist:

I got all through with spring calipers quite a number of years ago for what I considered excellent reasons, and some time ago I thought best to give the readers of the AMERICAN MACHINIST these reasons. I think now, as some people have got ideas from my articles that I did not mean to convey, that it is best to offer a few words of explanation.

When, in my first article, I referred to spring calipers, I only had in mind the genuine article. I was aware that there were lots of calipers on the market that retain about the same shape of the old ones, but are really quite different, and perhaps I should have called attention to the difference, but did not consider it necessary as I furnished a sketch of the wire affair that I had in mind.

Now, because some man by great skill, great patience and perseverance and lots of time (which all means expense) produces good work on a lathe that I should want to put in the scrap heap, it does not show that my judgment of that particular piece of scrap is at fault, does it? If you say no to this, then why would it not be in order to put those wire calipers in a box and ship them to Africa where the people could put them to good use as nose rings?

After we have disposed of wire calipers the question gets down to a better foundation. It seems to be a question that involves a design with the best combination of rigidity, lightness and convenience in adjusting and in handling. I do not expect that there are a great number of machinists who will agree with me, that it is just as easy to make a good guess at the weight of blow to rap a friction caliper in order to start it an indefinite amount, as it is to make an equally good guess of how much to turn a screw without graduating to produce the same result. It seems that Mr. A. K. A., in your issue of June 13th, has not seen quite all the screw adjusting devices for rivet calipers on the market. I have one of Starrett's make with a split in one of the legs which is made to open by a conical-headed screw, and, by so doing, springs the leg of the caliper and throws the point in. I have had this caliper about ten years, and believe it covers the ground for good screw adjustment. But one of the matters that I have been unable to decide, is whether it takes more skillful guessing to find out how much to turn the adjusting screw, than to find out how hard to strike the shop furniture with them in order to produce the same result.

Now, this screw adjustment could be easily put so far in the lead that I or no one else would doubt it. I should suggest graduating the screw or nut. Perhaps this will require some explaining, for many will think I mean to suggest a fine micrometer screw with accurately divided index, and that is not my intention. I mean simply an ordinary screw and nut, cut with die and tap in the usual way, and with a proper number of circular divisions, which may be cut by forcing the nuts through a die with the proper number of internal teeth to cut the lines.

Now, suppose the caliper feels too loose. You don't give the screw a turn without looking at it, but instead, use your eyes a little and notice how many divisions pass the line. Suppose you turn the screw four divisions and find the caliper too tight, then you know, as four divisions back it was too loose, that somewhere between is the proper place. Now you turn back two divisions and find the caliper too loose, then you know that the error is smaller and that the correct adjustment is between two and four, so you turn ahead one and try. By this method every trial counts, and each successive trial doubles your evidence; so by leaving the question of luck out altogether you have to make but a few trials to know just where to place the adjusting screw.

Right here let me illustrate a little case of bother. John Jones has a pair of inside and outside calipers with plain screw adjustment, and with large measuring terminals, which do not open parallel or otherwise, or at least it can't be proven how they open, not to John, for the geometry would make John dizzy—and perhaps some others, too. John sets his inside calipers to the hole correct. He is willing to swear to this, and then attempts to adjust the outside to them. He feels around carefully for the highest points, but fails to find any to touch, so decides that he should turn the adjusting screw a little, which, of course, will make them just right, and perhaps muses to himself on the lack of such a convenience as an adjusting screw years ago. But the little does not seem to do the business, and so a little more and then a *little* more, and so on, until he begins to doubt his ability to find those highest points at all, and gets rather reckless and gives the screw a good big turn, which brings the calipers in contact in *great shape*, when he commences the same racket of littles in the other direction. John manages to get considerable bother and worry out of the matter, for when the caliper feels too tight he doubts if at the last trial he found the highest points, and when they come too loose he thinks the same thing, and at last when he thinks he has worked as long as the law allows, he accepts the result and wonders if he did not have them adjusted just as well dozens of times before.

There is nothing but nonsense in working so much in the dark. There are lots of places in machine shops where the results are obtained more readily by repeated trials than would be possible otherwise, but it is usually possible and preferable to so arrange the trials that each successive one increases your evidence, and positively brings you closer to the result. I do not know of single points in machine shops where greater economy can be practiced than by making a revolution in calipers and methods of using them. Perhaps there are quite a number of machinists who have never thought that there is a better way of calipering work than the common way. Perhaps, also, there are quite a number of machinists who do not realize that they ordinarily weigh sizes instead of measuring them. The common way of calipering work is, for the finest points, to push the caliper over and notice the feeling which is really the weight or pressure, same as is registered on a spring balance. When this pressure seems to be right you call the work right.

There is another way, and a better way, I believe, to caliper work, which is by measuring instead of weighing, and I believe I have had sufficient experience with this new way to make me feel quite secure in saying that it is much better than the old. The new way requires some changes in machine tools that are not expensive nothing more than graduated dials on all adjusting screws. We have them already on milling machines and grinding machines, and one of the hardest things for me to understand is how they should happen to be desirable on these machines, and not so on lathes or planers. I think all machine shops could afford to furnish the machines with dials, and not charge that expense to the new plan of calipering.

I divide the work into two classes—rough and fine, and use two different calipers. I should term rough work where an error of .010 of an inch either way will be allowable, and fine work anything finer than this. For the rough work I use plain rivet calipers and a good steel scale, one with good sharp corners. I file the points of calipers so they will come together nicely, that is, bring the corners out sharp so they can be made to split the lines on a scale. I make the joint of caliper go quite easily, so I can set them quickly by pushing them over.

I have a shaft about 2¼ inches in diameter to be turned 2 inches, .010, more or less. I start a cut that will round it, then stop the lathe and push the friction calipers over, which sets them to size quite accurately. I then lay them on the scale with one point against the end, and notice what size they are in inches and fractions thereof. Now by a very little mental effort, I can tell what there is to take off, and so with the graduated dial on cross screw I can set just about the right cut first time trying. I feel positive that I can turn work to within .010 inch easily, and quite a lot inside not so easily. Now every job will come under the rough class at first, so the rough measuring calipers will not get very rusty in the finest shops. On the fine class I use a micrometer in precisely the same way (except that the scale for the micrometer combines both the caliper and scale, and so two separate tools are not required), that is, I measure variations instead of weighing them, as by the old method. It does not make the slightest difference whether you are working to standard sizes or merely fitting work together, you can translate your sizes into inches with the very best results in most cases.

In your issue of June 13th, Mr. A. K. A. says, "very much in connection with all calipers depends upon the man who uses them." Now is not this one of the things we want to avoid? The tend of modern improvements is toward making the work of the individual easier, toward throwing the weight of labor on inanimate things, and, in the long run, who says the individual will not be benefited? They tell us that our ancestral monkeys were in the habit of traveling by alternate jumps from the tops of tall trees, perhaps for the reason that there were less obstructions up there, and the scenery was better. Now it depended very much on the monkey's individual self whether he reached his intended destination or somewhere else, rather more than it does to day to travel in the modern railway train, does it not? Which is best? Do not calipers and methods of using them admit of improvement? A MECHANIC.

The Bicycle vs. the Horse.

Editor American Machinist:

Since the novelty of the bicycle has about worn off, and we have a reasonably clear knowledge of how it stands up, it may be of interest to take a look at this little roadster as a labor saving and time saving institution. In both of these qualities it has been shown to be pre-eminently successful, and as a thing of recognized utility, has undoubtedly come to stay.

The most interesting phase of the subject, perhaps, and especially to those interested in things of a mechanical nature, will be found in a study of the dynamics involved in this means of locomotion, as well as others with which we are familiar.

When we consider the small amount of energy put forth in the act of walking, it would seem that no mechanical means could be devised by which this effort can be made less laborious; especially when time or velocity of movement is not considered. The more this simple performance is analyzed, the more we are convinced that it cannot be improved upon.

The question might be asked here, does the long-legged man possess any advantage over the one having shorter legs, if both advance alike? Whatever may be the answer to this, it is evident that small feet have an advantage over larger ones, inasmuch as more energy must be put forth to overcome the inertia, and move the greater mass at each step. A striking proof of this is experienced in the tiring effect produced by heavy shoes, or the sudden accumulation of mud on the feet. A fit illustration, by the way, of the distinguishing features between mass and weight.

These times of lightning speeds will tolerate nothing slow. So the bicycle has come to the front, and its many phenomenal features make it an object of especial interest. In examining this wonderfully simple little piece of machinery, we naturally inquire the reason why it has become so popular, and why it has supplanted the horse to so great a degree.

It will readily be seen that first cost cuts no figure, for the two are about at par value.

The cost of maintenance is doubtless in favor of the bicycle, yet their owners are, no doubt, often made aware of the fact that the difference in this respect is not so great as might be supposed, and that the cost of keeping either well shod is no small item.

We think the prime cause for the "wheel" becoming so popular, may be found in the facilities it affords for transportation from place to place, and right here comes in the subject of the conservation of physical forces. In pursuing this, two things are made manifest. First, that the powers of a horse are used to poor advantage in carrying a single person over good roads; his strength being chiefly expended in moving his own massive carcass. Secondly, that the real work of moving 100 to 200 pounds, at a rate of 8 to 10 miles per hour, is comparatively small, and easily within the powers of a person; especially when friction is almost eliminated, and gravity is only appreciable on inclines, which are usually balanced by the ups and downs being about equal. We may also see in the bicycle, when on a perfectly level and smooth road, a striking analogy to the frictionless sled, mentioned by Professor Wood, to illustrate the relations existing between weight and mass, and from this standpoint we may look at some of the dynamical features connected with propelling a bicycle.

As an example, we will assume that the combined weight of a wheel and its rider is 193 pounds, and that he is traveling on a perfectly level and smooth road at the rate of 10 miles per hour, or 15 feet per second.

Then, $193 \div 32.166 = 6$, which is the mass due to this weight.

Therefore $15 \times 6 = 90$, the force required to attain this velocity. So that were friction in the machine and atmospheric resistance entirely eliminated, and the former in the bicycle is reduced to a minimum, then the wheel and rider would move on at this rate of speed without any further exertion. From this it will be clear, we think, that aside from the initial force spent in starting, the work required of the cyclist on reasonably smooth roads is very light. This will be made more apparent, perhaps, if we follow the rider until he strikes a grade, one, we will say, of 55 feet to a mile.

If when on such a grade a cord be tied to the bicycle, it will require a pull of 2 pounds to keep the wheel and man from rolling backward, for

$$\frac{55 \times 193}{5{,}280} = 2 \text{ pounds.}$$

Now, as we say the bicycle is geared

about 5 to 1, that is to say, the pedal moves around its axis 3 feet while the wheel advances 15 feet, so that to hold the machine by pressure on the pedal it will require $5 \times 2 = 10$ pounds pressure at this point. To this must be added enough force to propel the wheel forward at a rate of 6 miles an hour, we will say, or 528 feet per minute, and will assume that 5 pounds additional force will do this, making 15 pounds in all as the average pressure throughout each downward stroke of the pedal.

From the above data we may now determine what part of a horse-power a rider exerts while ascending a grade of this kind, or any grade that will absorb this amount of energy.

With a forward motion of the machine of 528 feet, we find the pedal moves around its axis at the rate of 105.6 feet per minute. Then

$$105.6 \times 15 = 1{,}584 \text{ foot-pounds.}$$

Taking a mechanical horse-power at 33,000 pounds raised one foot per minute, we have

$$\frac{1{,}584}{33{,}000} = .048 \text{ H. P.}$$

But we are told by Haswell that "the ordinary work of a horse may be stated at 22,500 pounds raised one foot in a minute for 8 hours a day." Then we would have

$$\frac{1{,}584}{22{,}500} = .07 \text{ H. P.}$$

In the first case we see the man-power put forth is about the $\frac{1}{20}$ part of a horse-power, and in the second about the $\frac{1}{14}$ part, which at most is only about one-third of that which he is estimated to be capable of performing.

The above estimates are not expected to be perfectly acurate, but they are sufficiently so to show the small amount of energy necessarily expended on such work as compared to that which a horse is capable of exercising, and further goes to show that the horse is about as unsuitable a means of conveyance in many respects as a 10-ton locomotive would be for drawing a street car.

We do not wish to relegate our noble friend, the horse, to obscurity or drudgery. He will always cavort beneath the belle and the beau, and air the pleasure seeker on the avenues. In husbandry he has his place, and on the battlefield is as indispensable as man. But in the pell-mell, hustle, and rush of city life the horse seems to be at a decided disadvantage as compared to the glib and featherlike little roadster—the bicycle.

"QUIRK."

Figuring Drawings—Indicator Cards From the Valve Stem.

Editor American Machinist:

Mr. Clough's views regarding the way in which dimensions should read, seem so reasonable that the wonder is why his suggestion is not more in vogue.

It would save the turning either of the head or the drawing, and the latter (perhaps the former also) would last the longer. The letter *F* to indicate "finish" permits in some cases an uncertainty as to the particular surface referred to, but, of course, a short line may be used to connect the *F* and the part to be distinguished. Another plan is to place a broken line adjacent to the surface, indicating "finish." This latter plan I think sufficient, but I have run across one conscientious draftsman who frequently used *both* on the same drawing.

Few are likely to find fault with anyone who desires to write under a *nom de plume* The choice of a pen name, however, involves the question as to how far the cognomen may reflect upon the views expressed by others. For instance, could anyone overlook the sarcasm of the situation in controverting the views of a writer who signed himself "Anti-Chump?"

It is suggested, I see, that the motion of the indicator be taken from the valve stem. I remember seeing some cards taken in that manner, by, I believe, Mr. F. Ruel Baldwin, which were reproduced either in the AMERICAN MACHINIST or *Power*. Whilst they had an uncanny appearance, they enabled the engineer to adjust the valves, and later, when cards were taken in the usual way, demonstrated that the scheme proposed would stand the strain of practice.

GATH.

Not a New Planimeter.

Editor American Machinist:

In your issue of 11th inst. I see a description of a "new" planimeter. Several months ago you published a description of one (copied in an English journal from your columns) which I had made and sold quite a number of years ago. You will find, upon examination, both to be identical in principle. Those which I have made have been in public use in this country for about ten years. HUGO BILGRAM.

Philadelphia, Pa.

[Mr. Bilgram's planimeter employs the same sliding wheel, and is, of course, founded upon the same mathematical principles, but there are new features about Mr. Willis' instrument, which we think justified us in calling it new—its ready use of any one of six different scales, and its adaptability to different conditions by adjustment of distance between centers, for instance. —ED.]

The Safety Valve on the Monkey Wrench.

Editor American Machinist:

We all know that a bolt can be screwed up further with a four-foot wrench than with the fingers. Mr. Johnson says this is due to the fact that *all* materials are elastic. Professor Wood's bolt, under a strain, due to the action of the wrench of 4,000 pounds, will be extended and the cylinder head will be compressed. Assume the extension and compression to be equal, and say .01 inch for each 4,000-pound load, and in proportion for any other load. Then if we apply an additional load of 4,000 pounds by putting steam into the cylinder, the bolt will have 8,000 pounds to carry *unless it stretches some more.* But 8,000 pounds will stretch the bolt .02 inch, and if the bolt be extended that much the elastic recoil of the compressed parts will be wholly relieved, and we will have left only the 4,000 pounds of steam load. As 4,000 pounds will not stretch the bolt .02 inch, and as 8,000 pounds will stretch it more than .01 inch, it is obvious that there must be a point somewhere between these distances when the load and the resistance will be equal. In this case, the load will be 6,000 pounds and the extension .015. Of this load, 2,000 pounds will be due to the elasticity of the compressed parts, and this furnishes all of the joint-making element. If we wish to be exceedingly "fine" in this matter, we cannot deduct all initial strain, due to screwing up, neither can we neglect it wholly. As I understand the scope of Professor Wood's article, he was not trying to be "fine," but just generally, or practically, accurate. The conclusion, that the initial strain on a bolt, due to the wrench, should be deducted from the ultimate strength available for use, is "practically" correct. The safety valve on the wrench is, therefore, a good idea. SUPERANNUATED.

Lists of Technical and Manual Training Schools.

Editor American Machinist:

I am very glad to learn that many manufacturers do realize the importance of sending their printed matter to technical schools. Besides the letters of inquiry in the AMERICAN MACHINIST, I have received a number of personal letters asking for a complete list of the engineering schools of this country.

The *Engineering News* of March 26, 1892, gives quite a complete list of schools that do work in engineering. This list has been republished by Dr. Thurston in his paper on "Technical Education in the United States," in the Transactions of the American Society of Mechanical Engineers for 1893. This list does not contain the names of a great number of manual training schools that buy as much general machinery as any of the schools doing advanced work. One of the best lists of schools and colleges, including all manual training and engineering schools, is the "American College and Public School Directory," published annually by C. H. Evans & Co., St. Louis, Mo.

C. R. RICHARDS.

University of Nebraska.

Design of Water Wheels.

Editor American Machinist:

In the discussion of the paper on the turbine at the Tremont Mills, Lowell, by Prof. De Volson Wood, at the Detroit meeting of the A. S. M. E., some one propounded a query as to whether the theory or the construction came first, the results of the tests of the turbine agreeing so closely with the theoretical results as worked out by Professor Wood.

I think this question can be very easily answered. My old friend, Mr. Boyden, spent many months, if not years, in working out the theory of the turbine before the first one was constructed, and the results of the first one proved that he had mastered the theory. As my friend, Mr. Wm. E. Worthen said, in the discussion on the paper by Mr. Allison, entitled "The Old and the New," Mr. Boyden used purely arithmetical calculations, and in the words of Professor Pierce, spent months in attaining results, which the higher mathematics would have given him in a few hours. He always had a large corps of young assistants at work, making calculations under his directions, and kept them very busy too. The curves in the crown and base plates of his turbines into which the sheet metal buckets were set and riveted, were all cut by a machine which he devised for the purpose, and which was built at the Lowell Machine Shop. It is so long since I saw it in operation, over 50 years, that my recollection of it is very indistinct, but so far as I can recall it, it cut a cycloidal curve.

I think he bequeathed all his papers and calculations on turbines to the late Jas. B. Francis, engineer for the Locks & Canals Co., of Lowell, and it is possible that they may be now in the possession of his son, Col. James Francis, who succeeded him in that position.

Mr. Boyden's own turbines gave a very high percentage of net effect at full gate, but the result at partial gate was poor, owing to the abrupt "cut-off" of the cylinder gate, and this has been instrumental in leading to the adoption of the "inward flow" wheels with external gates, where by suitable ajutages to the cylinder, or by various other forms of hinged or sliding gates, an unbroken flow of water to the buckets was obtained. These points were noted by me in a paper laid before the A. S. M. E. some years since.

In regard to Mr. Rockwell's suggestion that the manner of getting up new wheels was "to get up something and send it to Holyoke to be tested," I must also disagree with him.

The Swain wheel was got up by an ingenious mechanic who had worked at Lowell under Mr. Boyden's directions, and who applied his ideas to the farther development of Mr. Francis' "inward flow" wheel, which in turn was derived from the "Howd."

Stout, Mills & Temple got up the American turbine somewhat on the lines of Mr. Francis' wheel, and then copied the Swain for the "New American."

Rodney Hunt also copied the Swain very nearly, and the late J. H. Risdon spent years in calculation and experiment on the old "Van-de-water" wheel before the Holyoke flume was in existence. Mr. W. W. Tyler, now with Jas. Leffel & Co., was for many years with Mr. Risdon, and can, I believe, furnish some information as to the amount of theoretical calculation, which went into the development of that wheel. It is certain that since the Centennial Exposition in 1876, when the Risdon wheel distanced all competitors, many of the later wheels have drawn freely on its designs for buckets and gates, and the long, deep slant of the Risdon bucket is the main feature in some of the newer wheels.

The "Boyden wheel," *so called*, was at once adopted by various machine shops, but they either do not know, or paid no regard to, Mr. Boyden's rules for construction. They were simply crude copies of Fourneyron's general plan, and one of them, of which I have the record, a 72-inch wheel under 24 feet head, gave only 73½ per cent. at full gate, 50 per cent. at ¾ gate, and 30 per cent. at ½ gate.

The Fourneyron wheel, designed for a very small volume of water under a high fall, had very small apertures of discharge, and the result of copying it too closely at Fall River, was that the mills were stopped in the autumn by the wheels being filled with eels.

The same trouble from leaves and other rubbish has happened in many places, and has led to the general disuse of this wheel, and the substitution of forms with much larger apertures.

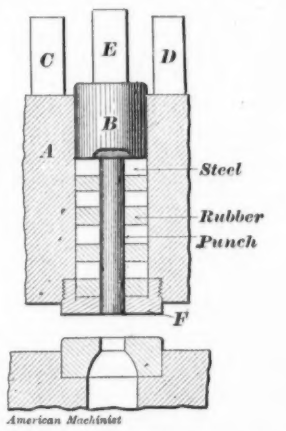
These newer forms of wheels, being usually cast in one piece, are also very much cheaper than the "built-up" Boyden turbine, and give better average net results.

Charleston, N. H. SAM'L WEBBER.

A Successful Small Punch.

Editor American Machinist:

The punch holder, shown by A. P. Hyde, Machinery Agency, is not good enough for severe duty. By inference, I "guess," the stripper, though not shown, is just as bad. For cylindrical punches, the stripper should be just as good as any other part of the machine. The inclosed sketch gives the idea of a machine that punched ¼ inch rivet holes in ½ inch merchant iron successfully, to the extent of many thousands. The slide *A* was bored about 1½ inches diameter and closed at the bottom by a hard steel bushing *F* to guide the extreme end of punch, which was about 4½ inches long. The alternate steel and rubber washers were about 1¼ inches diameter and ¼ inch thick. *B* was a round plug to push down the punch and steel washer, compressing the rubber, which, on the return, furnished all the "drawback"



required. *C*, *D* and *E* were cam-driven levers, timed as follows: *C*, *D* and *E* traveled together until the bar was strongly held between the guide *F* and the die; then with some springing of *C* and *D*, to suit slight differences in the work, the slide stopped, and *E* went on driving the punch through and letting go sharply. The compressed rubber withdrew the punch, and then *C* and *D* drew back the slide. As the bars were generally long ones, and often not quite straight, the pressure put on by the slide was made great enough to bring them to a fair bearing. The "drawback" head of the punch was just "pounded on," like a rivet. As it is thirty-five years since I used this machine, I cannot give any better figures, nor can I say how fast it ran, other than to say it did not keep me waiting after it was started. SUPERANNUATED.

It is consoling and reassuring sometimes to come across examples of bad workmanship in other trades than ours. A very bad case occurred lately to a physician whom we happened to know. By mistake (bad workmanship) he took a dose of chloral, enough to kill ten men. Then he went searching among his books for an antidote, and didn't find it (bad workmanship.) Then he ran into a neighboring doctor's office for help, and before anything effective could be done, or because it was too late to do anything, the unfortunate physician had paid for his bad workmanship with his life.

AMERICAN MACHINIST

PUBLISHED EVERY THURSDAY

BY THE

AMERICAN MACHINIST PUBLISHING CO.,

203 BROADWAY, NEW YORK.

FRED J. MILLER, Pres't. CHAS. W. BIGLOW, Treas.

C. A. HANSMANN, Sec'y.

FRED J. MILLER, Editor.

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Subscription.

$3.00 a year in advance, postage prepeid, in the United States, Canada, and Mexico.

$4.00 a year to Other Countries, postage prepaid.

Advertising.

Transient, 35c. per line, each insertion.

"Business Specials," 50c. a line.

The American News Company,

New York, is the Publisher's Agent, and dealers are supplied by all its branches throughout the United States and Canada.

For Europe:

THE INTERNATIONAL NEWS COMPANY, BREAM'S BLDG'S, Chancery Lane, LONDON, E. C., ENG., will receive subscriptions for the AMERICAN MACHINIST at 16/6 per annum, English currency, or 17 marks per annum, German currency, postpaid.

Subscriptions received in Paris, France, by E. TERQUEM, 31 Boulevard Hausmann, at 21 francs per annum, postpaid. Subscriptions received in AUSTRALIA by W. WILLIAMS, 17 and 21 Fink's Buildings, Melbourne.

Continental Office:

LEIPZIG, GERMANY. OSCAR NEUMAN, 27 Elster Str.

Chicago Office: 206 La Salle St.,

WM. D. MAHANEY, Agent.

New England Office:

Providence, R. I., 127 Pleasant St.

JOHN A. WALKER, Agent.

NEW YORK, JULY 25, 1895.

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The Bicycle's Day.

Rarely has any product of the machinist's art worked so rapid a revolution, or exerted so decided an influence upon our manner of life as is now witnessed in the case of the bicycle. This simple machine has for the first time really put the human race upon wheels; its relative cheapness, its ready availability, its exhilarating influence and general all-around usefulness, making it one of the most popular vehicles ever devised.

And, in our opinion, this popularity will be permanent or, at least, will continue until some possible new invention shall have superseded the present machine. It is true there are those who think wheeling is nothing more than a fad, which will soon disappear, but no one who has ever learned to ride, and who knows the pleasure there is in riding, and the useful service a wheel can render, ever expresses such an opinion. The fashionable set, which is now combining bicycle riding with five o'clock teas and other social functions, will, of course, give it up for some other fad, but the great mass of the people will, we feel sure, make increased use of the wheel for a long time to come, and that its use is already so general as to make its influence greatly felt is shown by the constant reference to it in connection with all sorts of new adjustments in social and business affairs.

How far-reaching its influence may be is shown by the fact that the decreased shipments of grain by lake boats to the East is attributed to the displacement of horses by the wheel, and by the trolley, and those who look after matters of taxation find that a number of industries connected with the use of horses have been seriously affected, and their tax-yielding powers considerably lessened. In lieu of this, it is therefore proposed to levy a special tax upon bicycles, which, it seems to us, is unwise. The wheel is essentially the poor man's vehicle; its use is desirable in every way, and should not be discouraged by a special tax, especially in view of the fact that the manufactories concerned in making them are already taxed in most cases.

One of the most striking effects of bicycle riding is to be seen in its effects upon road building and improvement, and this matter of road improvement is so important in its effects upon society as to be a surprise to those who investigate it for the first time. It is declared that improved roads in one county in New Jersey, which improved roads were the direct result of wheelmen's efforts, nearly doubled the value of the land lying along the improved roads, and, as neither industrial establishments, nor any kind of property, except land, was increased in selling value, it would seem as though this fact should clearly indicate where deficiencies in assessment valuations might properly be made up.

In the meantime the machinist and his allies are certainly deriving great benefit from this new development; the wheel upon the road having kept many another wheel turning, which would otherwise have been motionless during the past two years.

The number of wheels manufactured and sold last year in this country is estimated at 200,000, while this year's product will, it is thought, be quite double that number, and, so far as can be judged from contemplated enlargements of factories, and from contracts already made for material, next year's production will be over 700,000. We are exporting wheels in considerable numbers, and this export feature of the business seems likely to be important.

The Present Relation of the Foundry to the Machine Shop.

The modernization of the foundry and the revolution in its methods seem to have begun more recently than the same processes in the machine shop, but the changes have since occurred more rapidly, and to-day the transformation is perhaps more complete. This is not necessarily saying that the foundry is to-day in advance of the machine shop, nor in any way instituting any invidious comparisons in that line. But it must be evident to all that the relations of the foundry to the machine shop have greatly changed. The machine shop must, of course, have its castings, but is the foundry as necessary a part of each individual machine works as it once was? Does it always in these days pay the machine shop to have its own foundry? The obvious answer, the common-sense answer, apparently, and the answer most frequently formulated, unfortunately does not answer the question. The machine shop is run primarily to make money. The foundries, of course, are also run to make money, and they compete in a lively way for the privilege of furnishing castings to the machine shop, and, of course, they find profit in their work. Why, then, should not the machine shop retain all this profit for itself? Undoubtedly it should and it could if it could reproduce all of the conditions necessary to success. But herein is encountered the change that has occurred in the foundry. A foundry plant is more elaborate and costly than once was found sufficient, and the products of the foundry have differentiated so that even an independent and fully equipped foundry now has its special class of work, and does not make everything as every foundry used to do.

The larger engine-building shops, the machine tool builders, and all the establishments that turn out heavy machinery in considerable quantities must, of course, have their own foundries, but the number of large shops so equipped, who still find it to their interest to get special castings elsewhere, is astonishingly large. The machine shop without its own foundry is by no means as badly handicapped as it would have been, say, any time before the war. The small and growing shop to-day has one element of success in its favor, in that it is usually able to get good castings at low rates. We expect to see the independent machinery foundries grow, and to see all interests generally promoted by their continual development.

What is a Car Fender?

The Director of Public Safety in Philadelphia has done us a great service and relieved our mental strain by defining a car fender as follows:

"Nothing is a fender that does not project in front of the car in such a way as to keep people from coming in contact with the front of the car."

The fender is, of course, for the protection of the car, and not for the protection of the public. Anyone would understand this who would look at the fenders in use. The gridirons that project a yard or so in front of the car and about a foot from the track only need a series of spear points projecting in front of them to make them complete. They would then protect the car effectively, and they seldom fail now.

The fender idea is all wrong. No fender can be attached to the body of the car and be carried close enough to the track to enable it to do any effective service in saving persons from injury. It must be high enough to clear the track at all times, which means that if it surely clears the track when the car is heavily loaded, and especially when it is overloaded at one end, and pitching up and down, then when the car has a light load or is overloaded at the other end the fender will be high enough to pass over a person instead of scooping the body up. This is what usually happens with the fenders actually in use, and writers in the columns of the daily press are indulging in facetious comments upon the different styles of injuries inflicted by the fenders in the different cities.

When the cable cars commenced running upon Broadway in this city they were equipped with so-called fenders, and several fatalities were the almost immediate result. They did not have the worst form of fender that has been used or is still in use, so their death record did not run very high. A writer in these columns called attention to the absurdity of the fender idea in general, and to the fender device upon the Broadway cars in particular, and they were soon after taken off and since then the record for safety of the Broadway cars has been remarkably good. The Broadway fender was not the worst possible because it did not project out in front of the car, and, therefore, did not usually strike the victim at as high a speed as the advanced and improved (?) fenders do. While the person is being struck the motorman or gripman is usually applying the brake, so that the farther the car goes after the person is observed the slower it will go, and the fender that is even with the end of the car will not strike at as high a velocity as the fender which projects three or four feet in advance of it. The principal evil feature of the fender attached to the body of the car is that on account of the changing hight of the car with the distribution of the load the fender is necessarily so high above the track that it usually rides over the victim, rolling and crushing him, rather than running under and picking him up as it is assumed to do, and this feature is the more aggravated the farther the fender projects.

The safety of the public will be promoted by discarding the fender and the fender idea entirely. The wheel guard attached to the truck, that does not play up and down with the changing load or the vibration of the car, can be made to travel constantly within an inch of the track, and can also, and in practice actually does, run under and pick up instead of running over and crushing what may come before it. The fact that it is located so far back from the extreme front of the car is also an advantage, as it gives a longer time for stopping the car, or at least materially checking its speed before the object is reached. It really does seem that the best form of wheel guard close to the wheels and close to the track, the face slanting backward and the front platform of the car as free as possible of all projections beneath it, is the safest arrangement that has yet been devised. The laws or ordinances requiring fenders when no fender has been or probably can be invented are absurd.

A Piece-Rate System.

No one can read the paper by Mr. Fred. W. Taylor, part of which we publish in condensed form elsewhere, without being impressed by the fact that its author has given a great deal of very careful thought to a problem, the solution of which is of very great importance to those who work in, or who own machine shops, and yet which receives surprisingly little attention in the way of original thought.

The average employer seems never to bestow much real thought upon the matter of hiring and paying men. He usually aims to pay about the ruling rates of wages, and then depends upon his "system" or the vigilance of his foremen for results.

Mr. Taylor has fully understood the shortcomings of the ordinary plans, has fully appreciated the value of good feeling between employer and employe, and has adopted an unique method of securing the kind of service, without which it is impossible to get the maximum output from a manufacturing plant.

We hope the paper will be widely read and carefully studied. Every employer should at least be acquainted with it, and no workman should feel any hesitancy in calling his employer's attention to it. It is a record of actual experience in which very nearly, if not quite the utmost, possible amount of work was done in a machine shop, at a cost considerably below what had been possible by other plans, and yet by which the men's wages were considerably increased and good feeling all round promoted—a general result not so often attained, but that the method by which it was done ought to attract considerable attention.

The Demand for Iron.

Though iron now enters so largely into the construction of other things besides machinery, it yet remains true, probably, that

there is no better indication of the present or nearby future condition of the machinery business than is to be found in the demand for iron, and this demand is almost if not quite without precedent for this season of the year. The Iron Age, the leading authority in such matters, said last week regarding the demand for iron:

The markets have been relatively quiet, not because the situation is not as favorable as it has been, but simply because the majority of sellers are unable to take more business and because the buyers generally have covered their urgent requirements. The fact that makers are being crowded for deliveries is a good proof that the heavy demand continues in spite of the circumstance that we are in the dull season of the year. Usually, at this time, when the efficiency of labor is reduced by the hot weather, the majority of rolling-mills stop for repairs and stock-taking. This year every wheel must be kept turning to satisfy customers.

All true Americans will probably indorse the action of the engineer force of the "St. Louis," who, when they arrived at Southampton on the 3d, rushed their work forward as fast as possible, and then insisted upon going ashore on the 4th and celebrating the day. The officers of this only simon pure American steamship were unpatriotic enough to object to this, but that made no difference, though the men upon arrival here were fined one day's pay. They seemed not to mind this very much, however, and to think that the vindication of an American's right to celebrate his country's birthday was worth what it cost them.

The torpedo boat "Ericsson" seems to be particularly unfortunate. We have before mentioned some accidents which occurred to her machinery when making or preparing to make a trial run, and on the 17th inst., near New London, while running at high speed, a cylinder of one of the engines was wrecked and the escaping steam severely scalded several men who were in the engine room; the most severely injured man being William Merwin, a machinist, of Dubuque, Iowa—where the vessel was built. It is stated that Mr. Merwin had just received engineer's papers, after passing an exceptionally good examination.

Mr. W. H. Pike, Jr., who for the last two years has been superintendent of the shops of the Brady Mfg. Co., Brooklyn, N. Y., has resigned, and Mr. Oluf Tyberg, M. E., a well-known designer and engineer, has acquired an interest in the business, and takes the position of superintendent of the shops.

As the result of a competitive examination, Mr. Esdaile, Charlottetown, P. E. I., has been appointed Dominion Inspector of Boilers and Machinery of Steamboats for the province of Nova Scotia. Mr. Esdaile is numbered among the friends of the AMERICAN MACHINIST.

It is announced that the trial run of the "St. Louis" will probably take place in the English Channel sometime next month, and that "it will be conducted with extreme secrecy, no representatives of the press being permitted to be present."

The Engineer, of London, is to arrange a competitive trial of road carriages driven by steam or other power, and will give prizes amounting to 1,000 guineas to the most successful.

Literary Notes.

DIE MASCHINEN ELEMENTE. Ihre Berechnung und Konstruktion, mit Rücksicht auf die Neueren Versuche. Von Prof. C. Bach.

This work, written in the German language, treats on the elements of machine design. It is the third edition, revised to suit the most recent practice. Those who are acquainted with the German language will find this work to be an exceedingly valuable and useful one. It contains 610 pages 7x10½ inches, not including the 45 double-page mechanical drawings of various details of machinery, given at the end of the book; these drawings, and the general make up of the book, are of a high character. As to the reliability of the rules and formulæ we believe that the name of Prof. C. Bach is a sufficient guarantee for their correctness. The book is published by the J. G. Cotta'sche Buchhandlung, Stuttgart, Germany. Price not given.

QUESTIONS AND ANSWERS.

Questions of general interest relating to subjects discussed in our columns will receive attention in this department. The writer's name and address should always accompany the question. Neither correct initials nor location will be published when there is a request to that effect. If questions are enclosed with a business communication, they should be written on a separate sheet. We cannot undertake to answer questions in "next issue." This department is usually crowded, and questions must wait their turn to be answered. Neither can we undertake to solve mechanical or engineering problems, and send answers by mail.

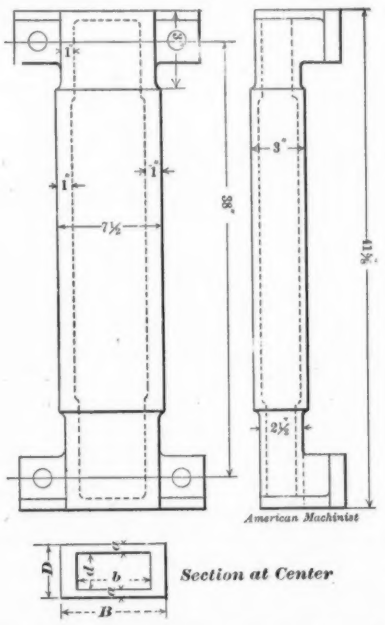
(288) B. A., ——, New Jersey, writes: Kindly refer me to a book or publication treating on such engines as are used in flying machines. *A.*—We do not know of a book which gives illustrations and descriptions of this class of engines; however, in the "Proceedings of the International Conference on Aerial Navigation," held in Chicago, August 1, 2, 3 and 4, 1893 (now published in book form by the *American Engineer and Railroad Journal*, 47 Cedar street, New York) you will find much that is useful to know in designing such engines, as well as much useful information in regard to the construction of the flying machine and its details. 2. Is there any standing award offered for a flying machine? *A.*—Not that we know of.

(289) H. T., Boston, Mass., asks: What kind of leather is used for hydraulic pump packing? *A.*—Oak tanned sole leather from the back of a hide gives very satisfactory results. 2. Are these leather packings lubricated? If so, what lubricant is used? *A.*—After the leather packing has been compressed to the desired form and then dried by a moderate heat, and finally trimmed, it is immersed in blood warm beef tallow, and when thoroughly soft the surface is wiped off and the packing placed in the recess prepared for it. The general treatment of the leather for the packing is as follows: It is soaked over night in clean water so as to make it soft and pliable, it is then cut to the required shape for compression in a cast-iron form; the process of compression must be slow; after compression the leather is dried by a moderate heat, then removed from the cast-iron form and carefully pared, after which it is immersed in the beef tallow as stated above. Failures result with poor leather, or leather of uneven thickness, insufficient time in soaking, and molds of improper shape, which are liable to break the grain of the leather, causing it to rot rapidly by water being forced through it by the pressure to which it is subjected.

(290) D. W., Chelsea, Mass., writes: Suppose an engine with a fly wheel 20 feet diameter, and a fixed cut off, no governor, is running at a uniform speed under a certain load. Now, on the other hand, suppose that we reduce the diameter of the fly wheel to 15 feet, but make no other change whatever, will this engine become more powerful? In other words, is the fly wheel considered to be a lever of the third class, and does it become more powerful as the length of lever is reduced, the power and point of application remaining the same? *A.*—You are evidently thoroughly mixed up on these subjects. We cannot see what the principle of the lever has to do with the action of a fly wheel. You even seem to be muddled up on the subject of the lever, probably due to the useless way of dividing levers into three classes, as given in the older text-books. All computation relating to levers of any kind are based on one fundamental formula, and there is no necessity of dividing levers into three classes. A fly wheel is not used for the purpose of increasing or decreasing the power of an engine. The pressure on the crank pin of an engine is variable during each revolution, and when this pressure is in excess of the mean, the energy due to this excess is stored up in the fly wheel, and when the pressure on the crank pin is below the mean the fly wheel gives out some of its stored-up energy. The velocity of rotation would vary considerably at different parts of a revolution if a fly were not used to store and restore the surplus energy. Hence the fly wheel is used for the purpose of giving the engine a uniform rotative speed. A reduction of the diameter of a fly wheel, and keeping the weight of the rim the same, may result in unsteadiness in the running of an engine.

(291) Ice, Dayton, Ohio, writes: In the transmission of power by a belt, I was compelled by circumstances to make the distance between the two shafts as small as possible, and in looking for some information about this matter in technical books and papers I could not find a thing that would advise me. But remembering that I had seen a plant where 125 horse-power was transmitted from an engine by means of a belt to a line shaft, 15 feet off from the center of engine shaft, both centers of shaft in a horizontal line, the same in my case, I thought I could transmit 30 to 40 horse-power with the shafts 14 feet 6 inches apart. In both cases no tension pulleys were used. But now the party complains about burning the belt, hot boxes, and some other things, and they have the same complaint in regard to another belt transmitting 20 horse-power, distance between shaft centers being 20 feet. These complaints make me believe that the plant was not properly erected. Please pass your opinion on this matter, and also give rule, if any, for the distance between shafts. *A.*—The distance between the pulleys is a little shorter than they should be for the best results. However, we believe that the principal cause of the trouble is due to the tightness of the belt. The belt should be allowed sufficient slackness to move with a loose undulating vibration on the returning side, as a test that it has no more stress imposed upon it than is necessary for transmitting the power. It is not easy to give a definite rule as to what the distance between the pulleys should be, circumstances generally have much to do with the arrangement, and the engineer must be guided by his experience and good judgment. A general rule may be stated thus: Where narrow belts are to run over small pulleys, 15 feet is a good average, the belt having a sag of 1½ to 2 inches. For wider belts working on larger pulleys, a distance of 20 to 25 feet does well, with a sag of 2½ to 4 inches. For main belts working on very large pulleys, the distance should be 25 to 30 feet, the belts working well with a sag of 4 to 5 inches. If too great a distance is attempted, the weight of the belt will produce a very heavy sag, drawing so hard on the shaft as to produce great friction in the bearings, while at the same time the belt will have an unsteady flapping motion, which will destroy both the belt and the machinery. Heating may also be caused by an insufficient bearing surface in the bearings, or by a weak line shaft, but our impression is that if the tension in the belt is decreased, the trouble will cease.

(292) C. V. A., Baltimore, Md., writes: Inclosed please find a sketch of a main crosshead guide for a vertical engine. The pressure on this guide is 6,946 pounds. Please give me a formula for computing the thickness of the faces of this guide so that they will be stiff enough to resist pressure



upon them; the sides are to be 1 inch thick. *A.*—The width of the guide being comparatively great for the pressure, the length of the crosshead will be comparatively short, so that we may assume that the whole pressure or load is concentrated at the center of the guide. The thickness of the sides is known, it is 1 inch; now let us assume a thickness for *a* of the faces, say, ¾ inch, and then compute the weight which this hollow guide will support with safety. We may consider this guide to be a hollow beam supported at the ends, 38 inches between the supports. The weight which a beam of this kind can support is found by the following formula:

$$W = \frac{4 \times S}{6 \times l} \times \frac{B D^3 - b d^3}{D}, \qquad (1)$$

in which W = weight or pressure in pounds, S = stress per square inch, for cast-iron we may take $S = 6{,}000$ pounds, l = distance between supports, B = outside breadth of guide, D = outside depth of guide, b = interior breadth, and d = interior depth; all these dimensions should be taken in inches. Taking a value 6,000 pounds for S the above formula will reduce to

$$W = \frac{4{,}000}{l} \times \frac{B D^3 - b d^3}{D}. \qquad (2)$$

Now substituting for the letters in formula (2) their values as given in the question, we have

$$W = \frac{4{,}000}{38} \times \frac{7.5 \times 3^3 - 5.5 \times 1.5^3}{3}$$

$$= \frac{4{,}000}{38} \times \frac{202.5 - 18.5}{3} = 6{,}456 \text{ pounds.}$$

This result is less than the given pressure on the guide, but since this pressure is to some extent distributed over the guide we may assume that the guide of the above dimensions is strong enough. And a thickness of ¾ inch for the metal of the face of guide is also strong enough for any pressure which any portion of this face has to resist.

BUSINESS SPECIALS

Transient Advertisements 50 cents a line for each insertion under this head. About seven words make a line. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue.

Gear Wheels, Gear Cutting, Grant; see page 592.

Forming Lathes, Mer. Mach. Tool Co., Meriden, Ct.

Milling Machs. Kempsmith Co., Milwaukee, Wis.

Marine Iron Works, Chicago (new catalog).

Selden Packing for stuffing box, with or without rubber core. Randolph Brandt, 38 Cortlandt St., N.Y.

Engine Castings, 1 to 6 Horse-power Vertical. The Humphrey Foundry, Bellefontaine, Ohio.

Squaring and Rotary Shears, Tinsmiths' Tools, Presses and Dies for sheet metal work, are made by the Niagara Stamping and Tool Co., Buffalo, N.Y.

Improved Duplex and Special Gear Cutters in stock and to order; Gear and Milling Cutters of all descriptions. R. M. Clough, Tolland, Conn.

American packing rings are in touch with the cylinder. New circular about rings and pistons. J. H. Dunbar, Youngstown, O.

New and valuable book, "Hawkin's Aids to Engineers' Examinations," with questions and answers; leather bound, gold edges, $2 postpaid; catalog. Theo. Audel & Co., 91 Liberty St., N. Y.

Machine work solicited; complete equipment modern machine tools; patternmaking, designing, experimental work; tech. assistance if required; best facilities & very reasonable prices. P. Pryibil, 512-524 West 41st St., N. Y. See page 596.

Just Published—"The Modern Machinist," by John T. Usher. Price, $2.50. Each of its 257 illustrations represents a new device in machine shop practice; a new book from cover to cover; agents wanted in every machine shop; send for special illustrated circular, Norman W. Henley & Co., 132 Nassau street, New York.

A Piece-Rate System—I.*

BY FRED. W. TAYLOR, GERMANTOWN, PHILADELPHIA, PA.

The ordinary piecework system involves a permanent antagonism between employers and men, and a certainty of punishment for each workman who reaches a high rate of efficiency. The demoralizing effect of this system is most serious. Under it, even the best workmen are forced continually to act the part of hypocrites, to hold their own in the struggle against the encroachments of their employers.

The system introduced by the writer, however, is directly the opposite, both in theory and in its results. It makes each workman's interests the same as that of his employer, pays a premium for high efficiency, and soon convinces each man that it is for his permanent advantage to turn out each day the best quality and maximum quantity of work.

The writer has endeavored in the following pages to describe the system of management introduced by him in the works of the Midvale Steel Company, of Philadelphia, which has been employed by them during the past ten years with the most satisfactory results.

The system consists of three principal elements:

(1) An elementary rate-fixing department.

(2) The differential rate system of piecework.

(3) What he believes to be the best method of managing men who work by the day.

Elementary rate-fixing differs from other methods of making piecework prices in that a careful study is made of the time required to do each of the many elementary operations into which the manufacturing of an establishment may be analyzed or

* Abstracted from a paper presented at the Detroit Meeting of the American Society of Mechanical Engineers.

divided. These elementary operations are then classified, recorded and indexed, and when a piecework price is wanted for work, the job is first divided into its elementary operations, the time required to do each elementary operation is found from the records, and the total time for the job is summed up from these data. While this method seems complicated at the first glance, it is, in fact, far simpler and more effective than the old method of recording the time required to do whole jobs of work, and then, after looking over the records of similar jobs, guessing at the time required for any new piece of work.

The differential rate system of piecework consists briefly in offering two different rates for the same job; a high price per piece, in case the work is finished in the shortest possible time and in perfect condition, and a low price, if it takes a longer time to do the job, or if there are any imperfections in the work. (The high rate should be such that the workman can earn more per day than is usually paid in similar establishments.) This is directly the opposite of the ordinary plan of piecework, in which the wages of the workmen are reduced when they increase their productivity.

The system by which the writer proposes managing the men who are on day work consists in paying *men* and not *positions*. Each man's wages, as far as possible, are fixed according to the skill and energy with which he performs his work, and not according to the position which he fills. Every endeavor is made to stimulate each man's personal ambition. This involves keeping systematic and careful records of the performance of each man, as to his punctuality, attendance, integrity, rapidity, skill, and accuracy, and a readjustment from time to time of the wages paid him, in accordance with this record.

The advantages of this system of management are:

First. That the manufactures are produced cheaper under it, while at the same time the workmen earn higher wages than are usually paid.

Second. Since the rate-fixing is done from accurate knowledge instead of more or less by guesswork, the motive for holding back on work, or "soldiering," and endeavoring to deceive the employers as to the time required to do work, is entirely removed, and with it the greatest cause for hard feelings and war between the management and the men.

Third. Since the basis from which piecework, as well as day rates, are fixed is that of exact observation, instead of being founded upon accident or deception, as is too frequently the case under ordinary systems, the men are treated with greater uniformity and justice, and respond by doing more and better work.

Fourth. It is for the common interest of both the management and the men to cooperate in every way, so as to turn out each day the maximum quantity and best quality of work.

Fifth. The system is rapid, while other systems are slow, in attaining the maximum productivity of each machine and man; and when this maximum is once reached, it is automatically maintained by the differential rate.

Sixth. It automatically selects and attracts the best men for each class of work, and it develops many first-class men who would otherwise remain slow or inaccurate, while at the same time it discourages and sifts out men who are incurably lazy or inferior.

Finally. One of the chief advantages derived from the above effects of the system is, that it promotes a most friendly feeling between the men and their employers, and so renders labor unions and strikes unnecessary.

There has never been a strike under the differential rate system of piecework, although it has been in operation for the past ten years in the steel business, which has been during this period more subject to strikes and labor troubles than almost any other industry. In describing the above system of management, the writer has been obliged to refer to other piecework methods, and to indicate briefly what he believes to be their shortcomings.

Among the risks of a manufacturing business, by far the greatest is that of bad management; and of the three managing departments, the commercial, the financiering, and the productive, the latter, in most cases, receives the least attention from those that have invested their money in the business, and contains the greatest elements of risk. This risk arises not so much from the evident mismanagement, which plainly discloses itself through occasional strikes and similar troubles, as from the daily more insidious and fatal failure on the part of the superintendents to secure anything even approaching the maximum work from their men and machines.

The simplest of all systems is the "day-work" plan, in which the employes are divided into certain classes, and a standard rate of wages is paid to each class of men; the laborers all receiving one rate of pay, the machinists all another rate, and the engineers all another, etc. The men are paid according to the position which they fill, and not according to their individual character, energy, skill, and reliability.

The effect of this system is distinctly demoralizing and leveling; even the ambitious men soon conclude that since there is no profit to them in working hard, the best thing for them to do is to work just as little as they can and still keep their position. And under these conditions the invariable tendency is to drag them all down even below the level of the medium.

The proper and legitimate answer to this herding of men together into classes, regardless of personal character and performance, is the formation of the labor union, and the strike, either to increase the rate of pay and improve conditions of employment, or to resist the lowering of wages and other encroachments on the part of employers.

The necessity for the labor union, however, disappears when *men* are paid, and not *positions*; that is, when the employers take pains to study the character and performance of each of their employes and pay them accordingly, when accurate records are kept of each man's attendance, punctuality, the amount and quality of work done by him, and his attitude towards his employers and fellow-workmen.

Every manufacturer must from necessity employ a certain amount of day labor which cannot come under the piecework system; and yet how few employers are willing to go to the trouble and expense of the slight organization necessary to handle their men in this way. How few of them realize that, by the employment of an extra clerk and foreman, and a simple system of labor returns, to record the performance and readjust the wages of their men, so as to stimulate their personal ambition, the output of a gang of 20 or 30 men can be readily doubled in many cases, and at a comparatively slight increase of wages per capita!

The clerk in the factory is the particular horror of the old-style manufacturer. He realizes the expense each time that he looks at him, and fails to see any adequate return; yet by the plan here described the clerk becomes one of the most valuable agents of the company.

If the plan of grading labor and recording each man's performance is so much superior to the old day-work method of handling men, why is it not all that is required? Because no foreman can watch and study all of his men all of the time, and because any system of laying out and apportioning work, and of returns and records, which is sufficiently elaborate to keep proper account of the performance of each workman, is more complicated than piecework. It is evident that that system is the best, which, in attaining the desired result, presents in the long run the course of least resistance.

The theory upon which the ordinary system of piecework operates to the benefit of the manufacturer is exceedingly simple. Each workman, with a definite price for each job before him, contrives a way of doing it in a shorter time, either by working harder or by improving his method; and he thus makes a larger profit. After the job has been repeated a number of times at the more rapid rate, the manufacturer thinks that he should also begin to share in the gain, and therefore reduces the price of the job to a figure at which the workman, although working harder, earns, perhaps, but little more than he originally did when on day work.

The actual working of the system, however, is far different. Even the most stupid man, after receiving two or three piecework "cuts" as a reward for his having worked harder, resents this treatment and seeks a remedy for it in the future. Thus begins a war, generally an amicable war, but none the less a war, between the workmen and the management. The latter endeavors by every means to induce the workmen to increase the output, and the men gage the rapidity with which they work, so as never to earn over a certain rate of wages, knowing that if they exceed this amount the piecework price will surely be cut, sooner or later.

But the war is by no means restricted to piecework. Every intelligent workman realizes the importance, to his own interest, of starting in on each new job as slowly as possible. There are few foremen or superintendents who have anything but a general idea as to how long it should take to do a piece of work that is new to them. Therefore, before fixing a piecework price, they prefer to have the job done for the first time by the day. They watch the progress of the work as closely as their other duties will permit, and make up their minds how quickly it can be done. It becomes the workman's interest then to go just as slowly as possible, and still convince his foreman that he is working well.

The extent to which, even in our largest and best managed establishments, this plan of holding back on the work—"marking time," or "soldiering," as it is called—is carried on by the men, can scarcely be understood by one who has not worked among them. It is by no means uncommon for men to work at the rate of one-third, or even one-quarter, their maximum speed, and still preserve the appearance of working hard. And when a rate has once been fixed on such false basis, it is easy for the men to nurse successfully "a soft snap" of this sort through a term of years, earning in the meanwhile just as much wages as they think they can without having the rate cut.

Thus arises a system of hypocrisy and deceit on the part of the men which is thoroughly demoralizing, and which has led many workmen to regard their employers as their natural enemies, to be opposed in whatever they want, believing that whatever is for the interest of the management must necessarily be to their detriment.

One method of temporarily relieving the strain between workmen and employers consists in reducing the price paid for work, and at the same time guaranteeing the men against further reduction for a definite period. If this period be made sufficiently long, the men are tempted to let themselves out and earn as much money as they can, thus "spoiling" their own job by another "cut" in rates when the period has expired.

When we recognize the real antagonism that exists between the interests of the men and their employers, under all of the systems of piecework in common use, and when we remember the apparently irreconcilable conflict implied in the fundamental and perfectly legitimate aims of the two; namely, on the part of the men:

The universal desire to receive the largest possible wages for their time.

And on the part of the employers:

The desire to receive the largest possible return for the wages paid.

What wonder that most of us arrive at the conclusion that no system of piecework can be devised which shall enable the two to cooperate without antagonism, and to their mutualbenefit!

Yet it is the opinion of the writer, that even if a system has not already been found which harmonizes the interests of the two, still the basis for harmonious co-operation lies in the two following facts:

First. That the workmen in nearly every trade can and will materially increase their present output per day, providing they are assured of a permanent and larger return for their time than they have heretofore received.

Second. That the employers can well afford to pay higher wages per piece even permanently, providing each man and machine in the establishment turns out a proportionately larger amount of work.

The truth of the latter statement arises from the well-recognized fact that, in most lines of manufacture, the indirect expenses equal or exceed the wages paid directly to the workmen, and that these expenses remain approximately constant, whether the output of the establishment is great or small.

From this it follows that it is always cheaper to pay higher wages to the workmen when the output is proportionately increased; the diminution in the indirect portion of the cost per piece being greater than the increase in wages. Many manufacturers, in considering the cost of production, fail to realize the effect that the *volume of output has on the cost*. They lose sight of the fact that taxes, insurance, depreciation, rent, interest, salaries, office expenses, miscellaneous labor, sales expenses, and frequently the cost of power (which in the aggregate amount to as much as wages paid to workmen), remain about the same whether the output of the establishment is great or small.

In fact, it has never occurred to most superintendents that the work of their establishments consists of various combinations of elementary operations which can be timed in this way; and a suggestion that this is a practical way of dealing with the piecework problem usually meets with derision, or, at the best, with the answer that "It might do for some simple business, but my work is entirely too complicated."

Yet this elementary system of fixing rates has been in successful operation for the past ten years, on work complicated in its nature, and covering almost as wide a range of variety as any manufacturing that the writer knows of. In 1883, while foreman of the machine shop of the Midvale Steel Company, of Philadelphia, it occurred to the writer that it was simpler to time each of the elements of the various kinds of work done in the place, and then find the quickest time in which each job could be done, by summing up the total times of its component parts, than it was to search through the records of former jobs, and guess at the proper price. After practicing this method of rate-fixing himself for about a year, as well as circumstances would permit, it became evident that the system was a success. The writer then established the rate-fixing department, which has given out piecework prices in the place ever since.

This department far more than paid for itself from the very start; but it was several years before the full benefits of the system were felt, owing to the fact that the best methods of making and recording time observations of work done by the men, as well as of determining the maximum capacity of each of the machines in the place, and of making working tables and time tables, were not at first adopted.

Before the best results were finally attained in the case of work done by metal-cutting tools, such as lathes, planers, boring mills, etc., a long and expensive series of experiments was made to determine, formulate, and finally practically apply to each machine the law governing the proper cutting speed of tools: namely, the effect on the cutting speed of altering any one of the following variables; the shape of the tool (*i. e.*, lip angle, clearance angle, and the line of the cutting edge), the duration of the cut, the quality or hardness of the metal being cut, the depth of the cut, and the thickness of the feed or shaving.

It is the writer's opinion that a more complicated and difficult piece of rate-fixing could not be found than that of determining

the proper price for doing all kinds of machine work on miscellaneous steel and iron castings and forgings, which vary in their chemical composition from the softest iron to the hardest tool steel Yet this problem was solved through the rate-fixing department and the "differential rate," with the final result of completely harmonizing the men and the management, in place of the constant war that existed under the old system. At the same time the quality of the work was improved, and the output of the machinery and the men was doubled, and, in many cases, trebled. At the start there was naturally great opposition to the rate-fixing department, particularly to the man who was taking time observations of the various elements of the work; but when the men found that rates were fixed without regard to the records of the quickest time in which they had actually done each job, and that the knowledge of the department was more accurate than their own, the motive for hanging back or "soldiering" on this work ceased, and with it the greatest cause for antagonism and war between the men and the management.

The difference between elementary rate-fixing and the ordinary plan can, perhaps, be best explained by a simple illustration. Suppose the work to be planing a surface on a piece of cast-iron. In the ordinary system the rate fixer would look through his records of work done by the planing machine, until he found a piece of work as nearly as possible similar to the proposed job, and then guess at the time required to do the new piece of work. Under the elementary system, however, some such analysis as the following would be made:

Work Done by Man.	Minutes.
Time to lift piece from floor to planer table	——
Time to level and set work true on table	——
Time to put on stops and bolts	——
Time to remove stops and bolts	——
Time to remove piece to floor	——
Time to clean machine	——
Work Done by Machine.	**Minutes.**
Time to rough off cut ¼ in. thick, 4 feet long, 2½ in. wide	——
Time to rough off cut ⅛ in. thick, 3 feet long, 12 in wide, etc	——
Time to finish cut 4 feet long, 2½ in. wide	——
Time to finish cut 3 feet long, 12 in. wide, etc.	——
Total	——
Add —— per cent. for unavoidable delays	——

It is evident that this job consists of a combination of elementary operations, the time required to do each of which can be readily determined by observation.

This exact combination of operations may never occur again, but elementary operations similar to these will be performed in differing combinations almost every day in the same shop.

A man whose business it is to fix rates soon becomes so familiar with the time required to do each kind of elementary work performed by the men, that he can write down the time from memory.

In the case of that part of the work which is done by the machine the rate fixer refers to tables which are made out for each machine, and from which he takes the time required for any combination of breadth, depth and length of cut.

While, however, the accurate knowledge of the quickest time in which work can be done, obtained by the rate-fixing department and accepted by the men as standard, is the greatest and most important step towards obtaining the maximum output of the establishment, it is one thing to know how much work can be done in a day, and an entirely different matter to get even the best men to work at their fastest speed or anywhere near it.

The means which the writer has found to be by far the most effective in obtaining the maximum output of a shop, and which, so far as he can see, satisfies the legitimate requirements, both of the men and the management, is the *differential rate system of piecework*.

This consists briefly in paying a higher price per piece, or per unit, or per job, if the work is done in the shortest possible time, and without imperfections, than is paid if the work takes a longer time or is imperfectly done.

To illustrate: Suppose 20 units or pieces to be the largest amount of work of a certain kind that can be done in a day. Under the differential rate system, if a workman finishes 20 pieces per day, and all of these pieces are perfect, he receives, say, 15 cents per piece, making his pay for the day $15 \times 20 = \$3$. If, however, he works too slowly and turns out, say, only 19 pieces, then, instead of receiving 15 cents per piece he gets only 12 cents per piece, making his pay for the day $12 \times 19 = \$2.28$, instead of $3 per day.

If he succeeds in finishing 20 pieces, some of which are imperfect, then he should receive a still lower rate of pay, say, 10 cents, or 5 cents per piece, according to circumstances, making his pay for the day $2, or only $1, instead of $3.

It will be observed that this style of piecework is directly the opposite of the ordinary plan. To make the difference between the two methods more clear, supposing, under the ordinary system of piecework, that the workman has been turning out 16 pieces per day, and has received 15 cents per piece, then his day's wages would be $15 \times 16 = \$2.40$. Through extra exertion he succeeds in increasing his output to 20 pieces per day, and thereby increases his pay to $15 \times 20 = \$3$. The employer, under the old system, however, concludes that $3 is too much for the man to earn per day, since other men are only getting from $2.25 to $2.50, and therefore cuts the price from 15 cents per piece to 12 cents, and the man finds himself working at a more rapid pace, and yet earning only the same old wages, $12 \times 20 = \$2.40$ per day. What wonder that men do not care to repeat this performance many times?

Whether co-operation, the differential plan, or some other form of piecework be chosen in connection with elementary rate-fixing, as the best method of working, there are certain fundamental facts and principles which must be recognized and incorporated in any system of management, before true and lasting success can be attained; and most of these facts and principles will be found to be not far removed from what the strictest moralists would call justice.

The most important of these facts is, that *men will not do an extraord nary day's work for an ordinary day's pay;* and any attempt on the part of the employers to get the best work out of their men and give them the standard wages paid by their neighbors will surely be, and ought to be, doomed to failure.

Justice, however, not only demands for the workman an increased reward for a large day's work, but should compel him to suffer an appropriate loss in case his work falls off either in quantity or quality. It is quite as important that the deductions for bad work should be just, and graded in proportion to the shortcomings of the workman, as that the reward should be proportional to the work done.

The fear of being discharged, which is practically the only penalty applied in many establishments, is entirely inadequate to producing the best quantity and quality of work; since the workmen find that they can take many liberties before the management makes up its mind to apply this extreme penalty.

It is clear that the differential rate satisfies automatically, as it were, the above conditions of properly graded rewards and reductions. Whenever a workman works for a day (or even a shorter period) at his maximum, he receives under this system unusually high wages; but when he falls off either in quantity or quality from the highest rate of efficiency his pay falls below even the ordinary.

It is not sufficient that each workman's ambition should be aroused by the prospect of larger pay at the end of even a comparatively short period of time. The stimulus to maximum exertion should be a daily one.

As far as possible each man's work should be inspected and measured separately, and his pay and losses should depend upon his individual efforts alone. It is, of course, a necessity that much of the work of manufacturing should be done by gangs of men who co-operate to turn out a common product, and that each gang of men should be paid a definite price for the work turned out, just as if they were a single man.

In the distribution of the earnings of a gang among its members, the percentage which each man receives should, however, depend not only upon the kind of work which each man performs, but upon the accuracy and energy with which he fills his position.

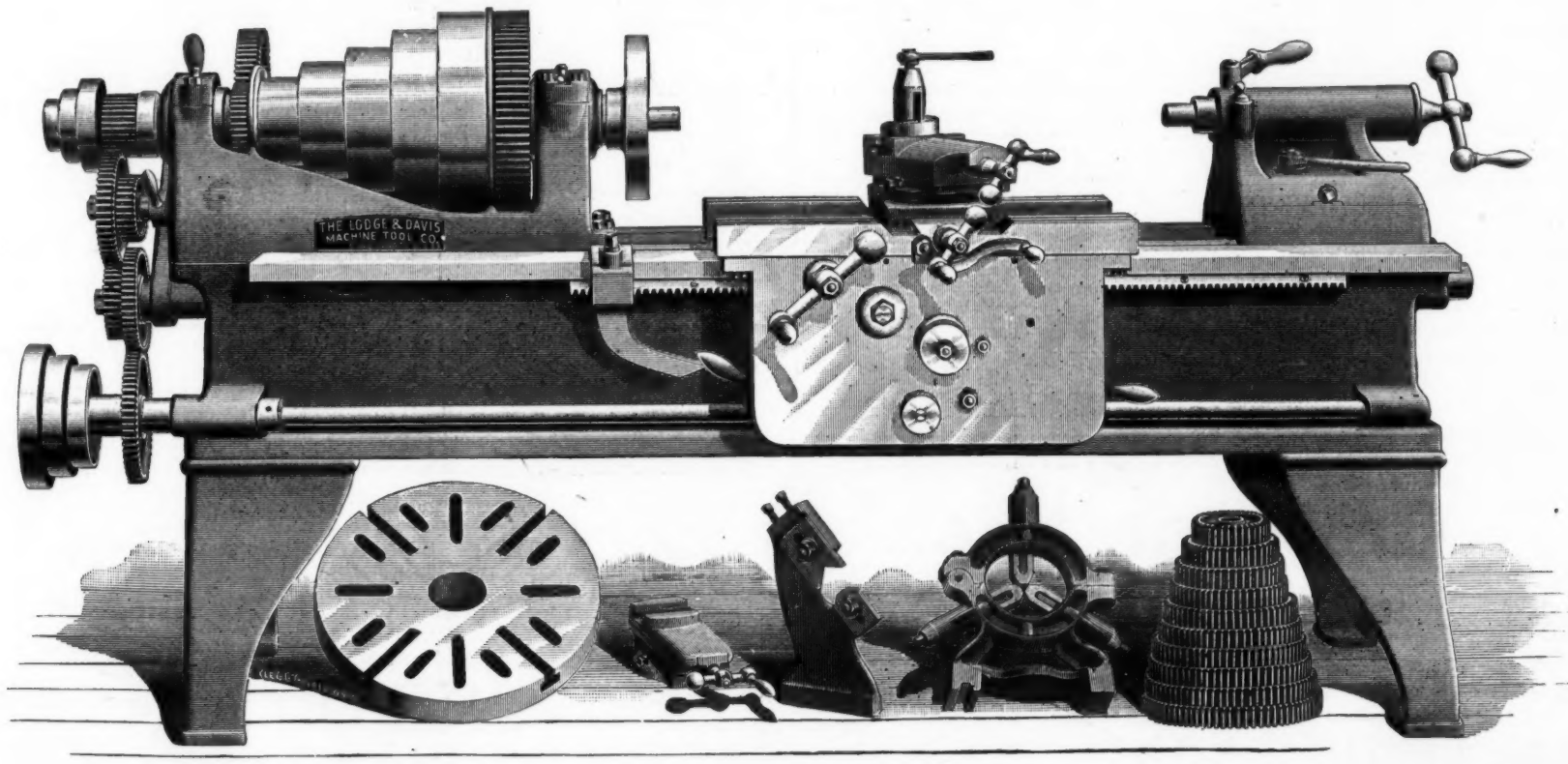
In this way the personal ambition of each of a gang of men may be given its proper scope.

Again, we find the differential rate acting as a most powerful lever to force each man in a gang of workmen to do his best; since if, through the carelessness or laziness of any one man, the gang fails to earn its high rate, the drone will surely be obliged by his companions to do his best the next time or else get out.

[*Concluded next week.*]

Improved Twenty-inch Lathe.

We are informed that the Lodge & Davis Machine Tool Co., of Cincinnati, Ohio, are re-designing their entire line of engine lathes, and we give herewith an illustration of the improved 20-inch lathe.



TWENTY-INCH ENGINE LATHE.

It will be seen that most of the distinctive features of the lathe have been retained; *i. e.*, it has its lead screw within the bed; the feed rod can be driven by either belt or gears; the feed motion is taken directly from the end of the spindle, and there is an automatic stop for the feed which can be adjusted to any point on the lathe bed. The feed motion and the lead screw nut cannot be in action at the same time.

The cone is now made with five steps and with the back gears gives ten speeds which are arranged in geometrical progression.

A taper attachment is furnished when required, which will bore or turn tapers up to 6 inches per foot, and is graduated.

The cross-feed screw is also graduated to facilitate tool setting.

The entire lathe is considerably heavier than formerly, and the bearing of the carriage upon the ways and other bearings have been increased in size.

An Automatically Expanding Tube Scraper.

We illustrate on next page a tube scraper which is new and which seems to possess decidedly novel and interesting features. The

construction of the scraper will be readily understood from the cut. A central hub carries, according to the size of the scraper, two, three or four elastic, converging steel strips, upon the outer ends of which the scraper blades are fastened, and renewable when worn out. The rod or handle of the scraper slides freely through the central hub and screwed upon the end of it is a disk which, as the rod is pushed forward, comes in contact with the converging strips and distends the scraper blades. A collar upon the rod outside the central hub serves as a stop for the handle when it is pushed forward. To adjust the scraper to compensate

FLUE SCRAPER.

for the wear of the blades, or for different sizes of tubes, the handle is turned around in the scraper and the distending disk is advanced or withdrawn as required. When the scraper is in the tube that is to be cleaned, if the handle is pushed suddenly inward, or forward, the blades are distended and scrape the flue as required. When the handle is drawn backward the blades collapse and the scraper moves without resistance. A ram is attached when desired to the larger sizes. This ram is a slip joint allowing a limited longitudinal movement of the handle without moving the scraper. By this means a hammer or rammer action can be given to the scraper, enabling tight places to be passed with comparative ease. The material for every part of the scraper is that which has been found to be most suitable for its special services. Three sizes of the scraper are made covering all sizes of tubes from 2 to 6 inches. In connection with the scraper is also furnished a "sweeper" consisting of asbestos disks held between conical collars. The scraper and sweeper are made by Fairies Mfg. Co., Decatur, Ill.

NEW CATALOGS.

There are three sizes of Standard Catalogs, 9" × 12", 6" × 9" and 4½" × 6". We recommend the 6" × 9" size for machinery catalogs. When they must be larger or smaller, one of the other standard sizes should be adopted if possible.

We have received the catalog for 1894-95 of the University of Minnesota, containing announcements for 1895-96. This school is located at Minneapolis, and has departments in which the various branches of engineering and mechanic arts are taught. The catalog is sent to all who apply for it; it is 5¾x8⅝.

The Sebastian Lathe Co., Cincinnati, Ohio, send us an illustrated catalog and price list of engine and speed lathes, foot lathes, emery grinders and grindstone frames. The tools of this firm are well known to our readers. The catalog is 5⅞x8¾.

The Straight Line Engine Co., of Syracuse, N. Y., have issued a revised and extended list of users of their well-known Straight Line engine, names and addresses being given in each case. A summary of these shows that 541 engines are in use, that orders have been duplicated and repeated by 110 different purchasers, one party having 22 engines, and 70 users having two engines each. Two-thirds of all the engines are sold for electrical purposes, and it is stated that only one, except those destroyed by fire, has ever gone out of service. One hundred and fourteen are running in New York City and 51 in Syracuse. The catalog is standard size, 6x9.

The Gates Iron Works, 650 Elston avenue, Chicago, Ill., send us five catalogs, each of which illustrates and describes certain portions of their work. Catalog No. 1 is devoted to the Gates rock and ore breakers, with elevating, screening and conveying machinery used in connection with these breakers. Catalog No. 4 is devoted to the illustration of screens, hoists, cars, crushing and pulverizing machinery for treatment of ores, road material, etc. Catalog No. 5 is devoted to standard rock and ore breakers, steam stamp mills, metallurgical appliances, concentrating, amalgamating, smelting, elevating, and other machinery especially devoted to use in mines. Catalog No. 6 is devoted to gold and silver mills. Catalog No. 7 to the Trapp pneumatic dumping car, and others for all industrial purposes and mining operations. These catalogs are all standard size (6x9), and are sent to those interested, upon application.

MANUFACTURES

The Ames Iron Works, of Oswego, N. Y., have advanced wages 10 per cent.

The Lackawanna Iron & Steel Co., of Scranton, Pa., advanced the wages of their 600 men 10 per cent.

The Birmingham Iron Foundry, of Birmingham, Conn., has increased the wages of all hands 10 per cent.

Hotchkiss Bros., of Torrington, Conn., have broken ground for a factory which will be 90x200 feet.

The Bannockburn Textile Works, of Pottstown, Pa., has increased the wages of all their hands 12½ per cent.

The Crane Company, of Chicago, have advanced wages 10 per cent., making the rate the same as early in 1893.

The Pullman Palace Co., of Chicago, Ill., has increased the wages of their 4,000 employes at its shops 10 per cent.

The Bullard Electric Co., of Chicago, Ill., has been organized, with $25,000 capital stock, by Chas. W. Bullard and others.

Peck, Stowe & Wilcox Branch Works, at East Berlin, Conn., is running full time, having been on short time for over a year.

It is announced that the foundry of March, Brownbeck & Co., of Reading, Pa., which was recently destroyed by fire, is to be rebuilt.

The Calleton Cotton-mills Co., of Wattesboro, S. C., has been incorporated by J. M. Klein, A. C. Savage, A. Wichman, J. R. Stokes and A. C. Shaffner.

The Spafford Planing-mill Co., of Rockford, Ill., has been organized with a capital stock of $20,000, by John Spafford, Frank L. Cleveland and Julian C. Shepherd.

The McLean County Milling Co., of Bloomington, Ill., has been incorporated by Burton Neal, Thomas C. Kerrick and Henry C. Spencer, with a capital stock of $30,000.

The Southern Shuttle & Bobbin Co., of Westminster, S. C., has been incorporated by Edwin G. Spaulding, Oscar S. Duff and Young E. Pitts, with $5,000 capital stock.

The Norris Cotton-mill Co., recently incorporated at Central, S. C., will shortly erect a plant. The officers of the company are: D. K. Norris, president, and J. V. Smith, secretary.

The Susquehanna Rolling Mill, of Columbia, Pa., which was recently burned, is soon to be rebuilt. The new structure will be entirely of iron, and will be much larger than the old one.

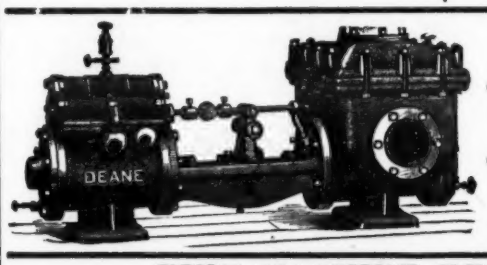
It is announced that the Mergenthaler Linotype Co. has absorbed by purchase the Rogers Typograph Company, which brings to an ending what has been very expensive litigation.

The name of the Leland, Faulconer & Norton Co., of Detroit, Mich., has been changed to the Leland & Faulconer Mfg. Co., Mr. Norton having retired from the business some time ago.

The Bickford Drill and Tool Co., Cincinnati, Ohio, have secured ground near their present plant, and will erect entirely new shops, especially designed for their business of building radial and other forms of drill presses.

The Hoppes Mfg. Co., Springfield, Ohio, will build an addition to their works, which will be equivalent to an enlargement of about 50 per cent., and will put in cranes or overhead trolleys which will facilitate the handling of work.

It is announced that Frederick E. Bruce, late representative of the Stirling Boiler Co., at Cleve-



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Send for "The Deane Specialties."

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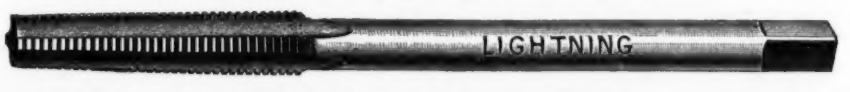
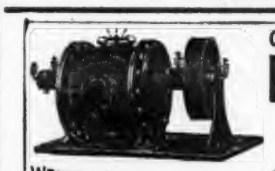
"Lightning" and "Green River" Screw Plates, Dies, Tap Wrenches, Bolt Cutters and Drilling Machines for Hand and Power, Punching Presses, etc.—SEND FOR CATALOGUE.



WILEY & RUSSELL MFG. CO., - - Greenfield, Mass.



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SAVES LABOR in being able to run at GREATLY INCREASED SPEEDS. FEWER GRINDINGS. No WASTE in redressing.
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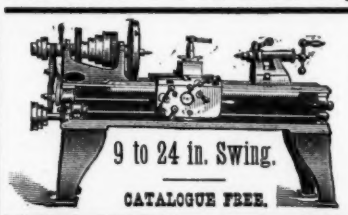
BOSTON: 11 & 13 Oliver St., NEW YORK: 143 Liberty St.



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All these are comprised in the make-up of our lathes and are the four necessary points in the construction of a good tool. Add to these a FIFTH and a very important one, the price, which we make very low to prompt cash buyers, and you have the story. Our catalogue will tell you all about our lathes, planers, shapers, etc.
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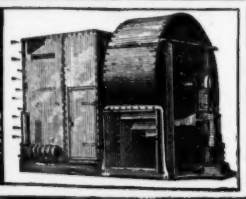

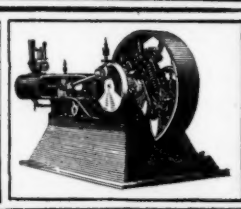

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ARE SUPERIOR TO LATHES FOR FACE PLATE WORK.
We have a variety of sizes and a large stock for immediate shipment.
THE BULLARD MACHINE TOOL CO.,
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New York Office, 86 LIBERTY STREET.

land, Ohio, will take charge of the New York office of the National Water Tube Boiler Co., his office will be at 74 Cortlandt street.

The E. & B. Holmes Machinery Co., of Buffalo, N. Y., has been incorporated with $100,000 capital. The directors are: Edward Holmes, Britain Holmes, Edward H. Holmes and Walter F. Cooke, of Buffalo, N. Y., and Albert Talamao, of Alden, N. Y.

Owing to delays caused by the new sewerage system and an injunction by the N. Y. & N. E. R. R., the electric road between Bristol and Plainville will probably not be running until August 1st. The power house and electrical plant is fast being completed.

The Edwards Automatic Car Fender Co., of Brooklyn, N. Y., has been incorporated with $100,000 capital, by Patrick J. Carlin, Henry W. Rozell, Joseph H. Cuyler, John Barnes and Michael F. McGoldrick, of Brooklyn, N. Y., and Charles Edwards, of Freeport, N. Y.

The P. & F. Corbin Co., of New Britain, Conn., have commenced to build a new building in connection with their already extensive plant. Dimensions about 300 feet by 90 feet, 4 stories brick and stack in the neighborhood of 200 feet high, which towers already above any of New Britain's highest structures.

The Builders Iron Foundry, of Providence, R. I., announce that they have added to their business a department for the manufacture and sale of a full line of wood wheels and grinding and polishing machinery with suitable countershafts. Mr. Wm. C. Buell will have charge of the sales in this department.

The Selle Gear Company, of Akron, Ohio, have purchased the governor business from H. E. Olbrich, Cedar Falls, Iowa, and will hereafter manufacture and sell the Replogle electric water-wheel governor under the name of the Replogle Governor Works. Mark A. Replogle will act as chief engineer.

The Springfield Machine Tool Co., Springfield, Ohio, are getting ready to build an enlargement of their shops at once, and have in contemplation in the near future a still further enlargement, these together being equivalent to more than doubling their present plant. They report business as very good, and have been working nights.

Mr. John E. Searles, a well-known capitalist, has been elected president of the Hyatt Roller Bearing Co., and Mr. Henry Bancroft, formerly of Messrs. Wm. Sellers & Co., has been appointed manager of the manufacturing department. The New York office and the selling department remain in charge of the secretary of the company, Mr. F. V. M. Hudson.

The Pope Mfg. Co., Hartford, Conn., are particularly busy, about 2,400 men being at work in two gangs—one day, one night, making the working day about 21 hours, the business department receiving about 1,000 communications and telegrams per day. At present turning out about twice as many wheels as usual. Hartford Wheel Works are operated by this concern this year.

The Cleveland Gas Engine Co., of Cleveland, Ohio, have just organized a stock company for the ourpose of manufacturing gas and gasoline engines from one to ten horse-power. They are now getting their building in shape for their machinery, and have closed a contract with the Lodge & Davis Machine Tool Co., of Cincinnati, Ohio, for the entire equipment of machine tools.

One of the latest instances of increase of wages is that of the Nicholson File Co., of Providence, R. I. Notices have been posted in their three factories, two of which are at Providence and one at Pawtucket, R. I., announcing a material advance in wages. Upwards of 1,000 hands will be affected by this increase, and the action was voluntary and a pleasant surprise to the help. The output of the Nicholson File Co. is said to be more than 50 per cent. of the entire file product of this country.

It is announced that the article made by the Joseph Dixon Crucible Co., Jersey City, N. J., which has been known under the name of "pipe-joint grease," is hereafter to be known as "Dixon's graphite pipe-joint compound." This compound has been found to be very much better than red lead or similar substances usually employed in making joints in steam or other pipes, especially as while it is equally effective in making the joint tight, it enables joints to be disconnected with much greater facility when desired.

Machinists' Supplies and Iron.

NEW YORK, July 20, 1895.

Iron—American Pig—We quote standard Northern brands, $14 for No. 1; $13 for No. 2; $12.25 for No. 2 Plain, and $12 for Gray Forge. Southern brands, $13.50 to $14 for No. 1; $13 to $13.25 for No. 2; $12.50 to $12.75 for No. 3; $13 to $13.25 for No. 1 soft; $12.75 to $13 for No. 2 soft; and Foundry No. 4, $12.25 to $12.50.

Antimony—A fair jobbing business has been done, and prices remain steady. We quote L. X., 8¼c. to 8¾c.; Cookson's, 8¼c. to 8⅜c.; Hallett's, 7⅛c. to 7.15c.; U. S. French Star, 7.35c.; Japanese, 6.90c. to 7c.

Lard Oil—Prime City we quote at 50c. to 51c.

Copper—The market is very firm and active. Lake Copper has been sold at 10¾c. to 11c., but is doubtful if any more can be bought at the latter figure, 11¼c. is now asked. Casting Copper of good brands is held at 10⅛c.

Lead—The market is very firm, the demand is good, and prices remain nearly stationary, 3.32½c. to 3⅜c. is quoted for New York delivery.

Spelter—The market is firm in tone and the transactions have been fairly good. For New York delivery 3.70c. to 3.75c. is quoted.

Tin—The market is quiet and firm and prices are fairly steady; for round lots the prices are 14.15c. to 14.20c. net cash.

✻WANTED✻

"Situation and Help" Advertisements only inserted under this head. Rate 30 cents a line for each insertion. About seven words make a line. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue. Answers addressed to our care will be forwarded.

TO SUBSCRIBERS.

On and after July 4th this paper will give two free insertions under this heading to those in want of positions. The advertisement to occupy a space of not more than five lines. Additional space or insertions must be paid for in advance at regular rates.

Wanted—Bright, active machinists to canvass for subscription to AMERICAN MACHINIST, liberal commission. Address, with refs., Subscription Dep't, AMERICAN MACHINIST, 203 Broadway, N. Y.

Wanted—Machinery to build: special, steam mill, hydraulic. F.C. & A. E. Rowland, New Haven, Conn.

Young draftsman, 20, wishes to change; 3 years exp.; small pay expected. Box 57, AM. MACH.

Draftsman wants position; exp., Sweden and America; good refs. Robt. Palm, Bainbridge, N.Y.

Wanted—Position as foreman machinist or in charge of power plant; 17 years' experience; good references. Box 60, AMERICAN MACHINIST.

Wanted—A good patternmaker to work on water-wheel patterns. Apply or correspond with William Dolan & Co., Logansport, Indiana.

Wanted—Position by a draftsman with technical education and experience in an engine building shop. W. M. C., AMERICAN MACHINIST.

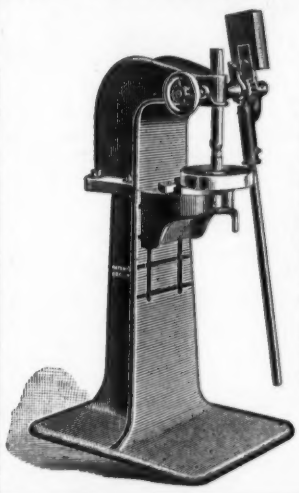
Wanted—A few first-class tool makers and die sinkers. Apply, stating price and experience, Remington Arms Company, Ilion, N. Y.

Wanted—A working foreman to take charge of molding room, work on engines and general machinery; competent man only. Box 54, AM. MACH.

Wanted—A situation by a first-class draftsman; A1 references furnished. Address Box 62, AMERICAN MACHINIST.

(*Continued on Page 594.*)

The Greenerd Arbor Press.



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3000 VARIETIES FILES
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LECOUNT'S NEW EXPANDING MANDREL.

Amateur's Size.
Taking anything from ⅛ to 1 inch inclusive.
Price.....$5.00
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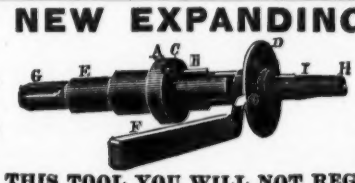

Machinist's Size.

No.				Price.
1	⅛ to 1	in.		$10
2	1	"	1½ "	14
3	1½	"	2 "	18
4 (with screws)	2	"	3 "	33
5 " "	3	"	4 "	44

IF YOU WILL TRY THIS TOOL YOU WILL NOT REGRET THE EXPENSE.
C. W. LECOUNT, SOUTH NORWALK, CONN.
SPECIAL MANDRELS FOR SPECIAL JOBS MADE TO ORDER.
These goods are for sale by CHAS. CHURCHILL & CO., L't'd. 21 Cross St., London, England.

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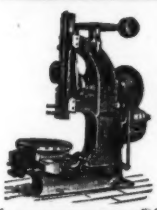

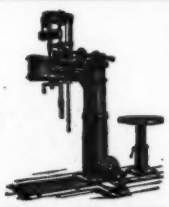

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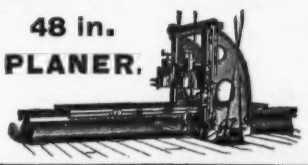

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(*Continued on Page* 595.)

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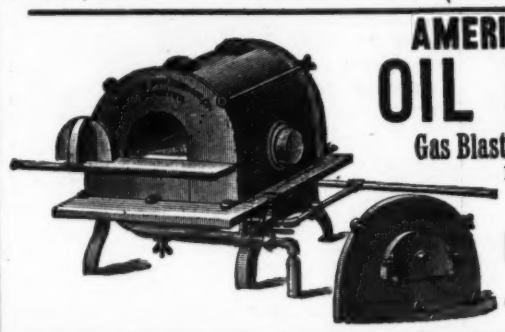

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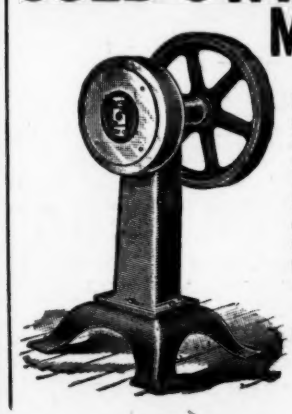
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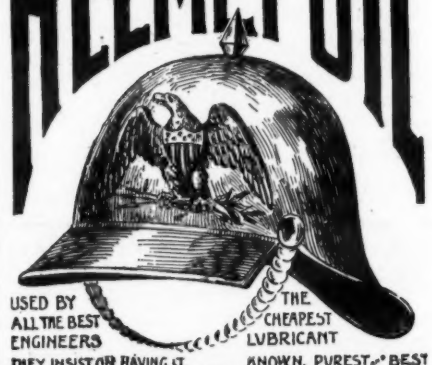
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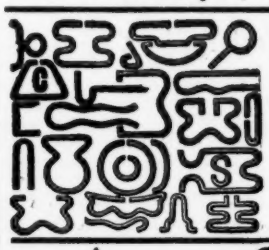
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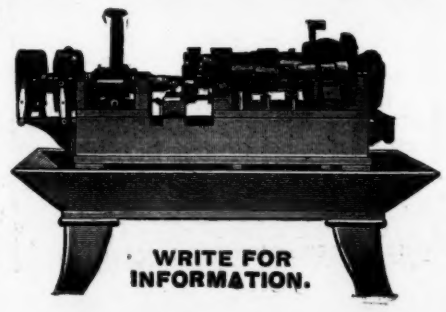
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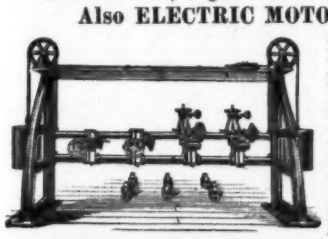

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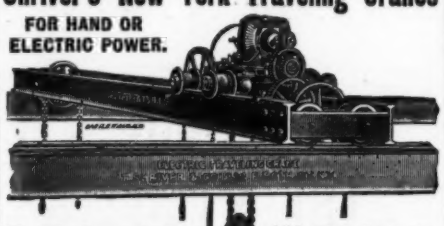

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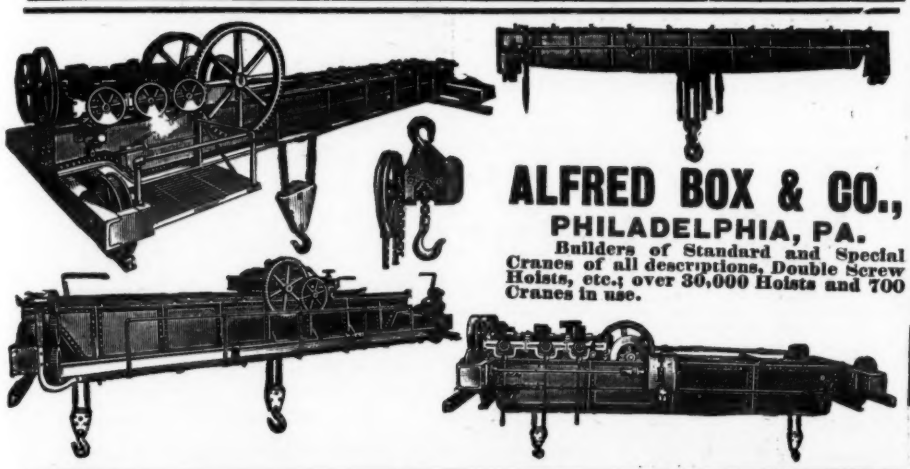

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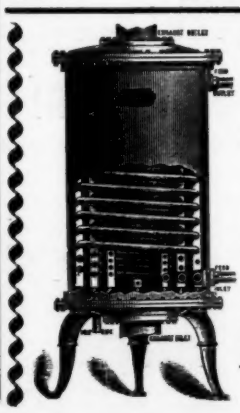

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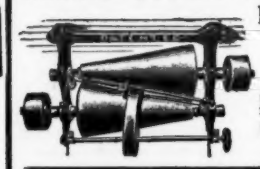

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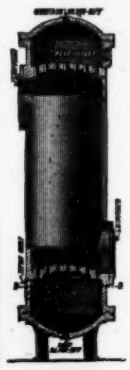

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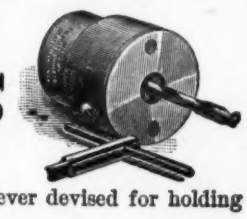

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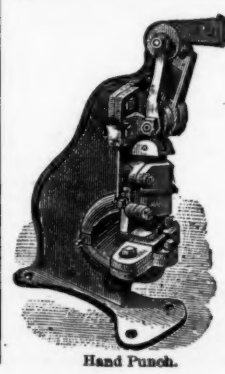

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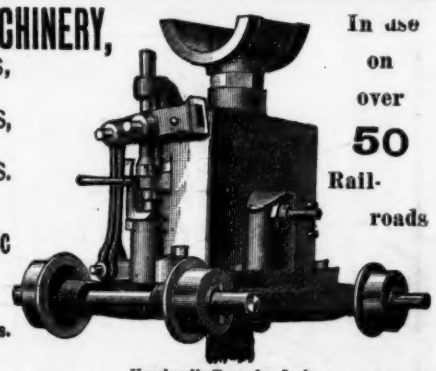

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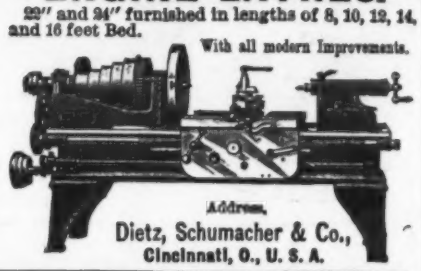

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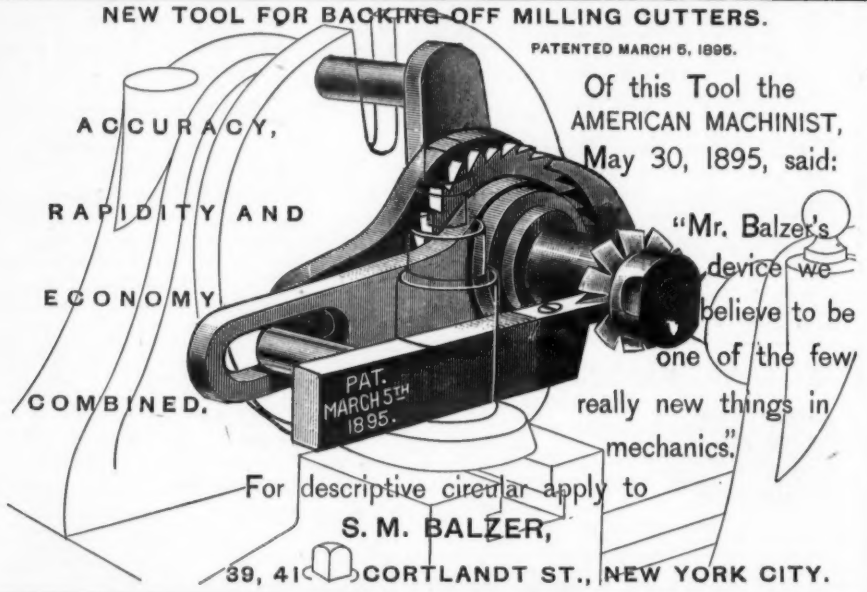

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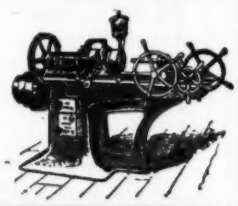

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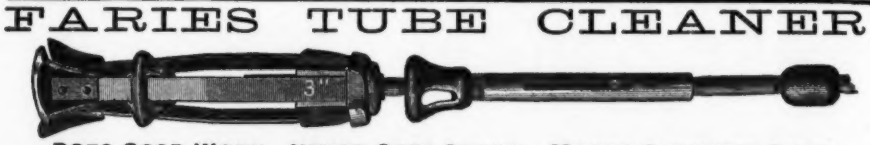

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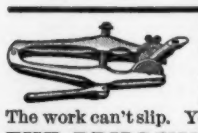

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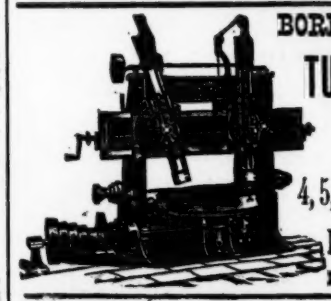

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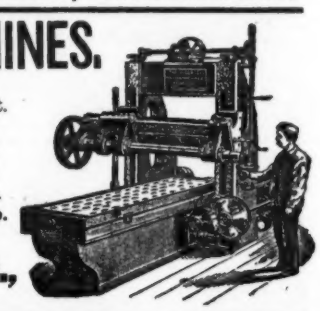

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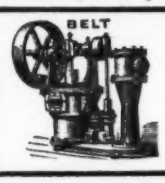

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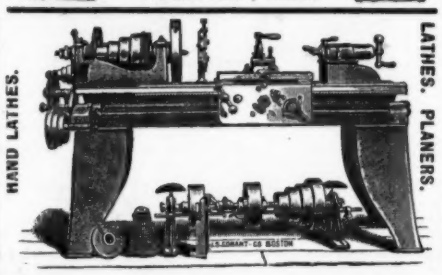

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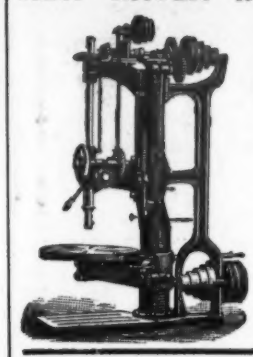

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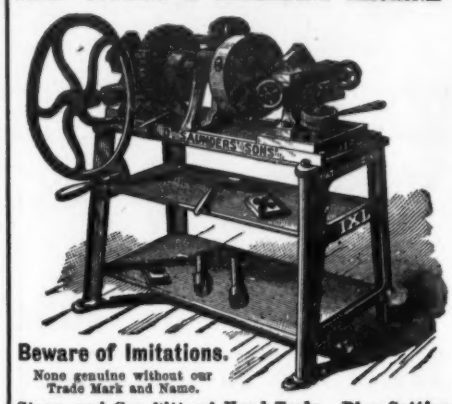

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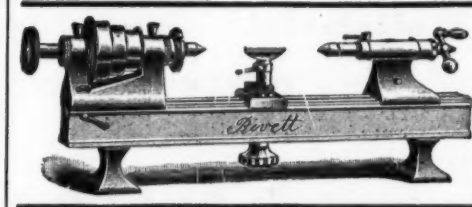

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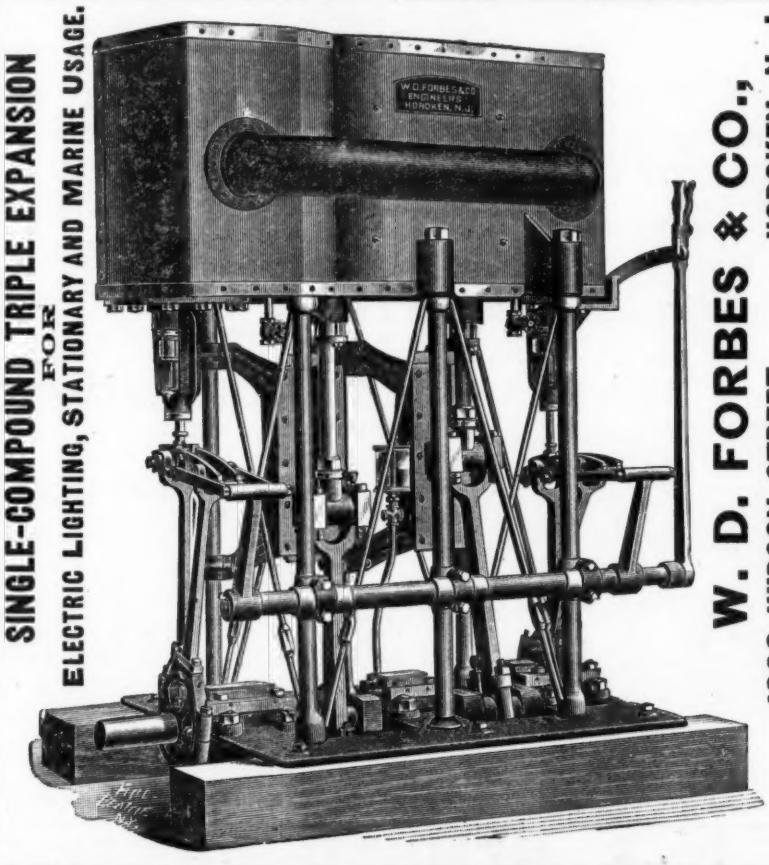

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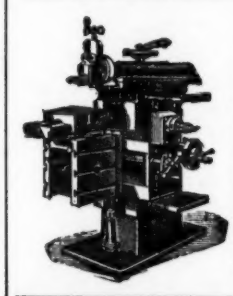

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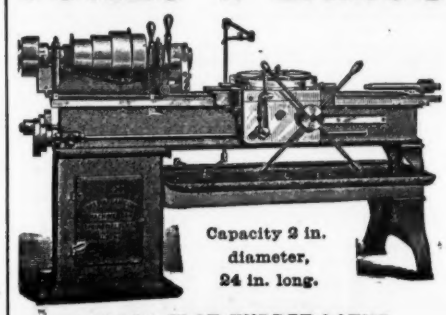

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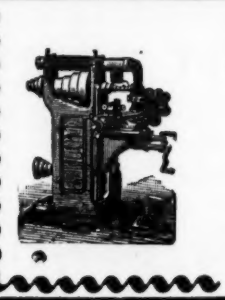

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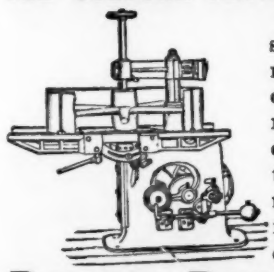

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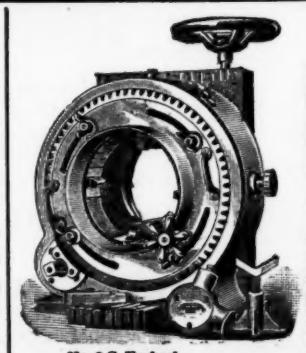

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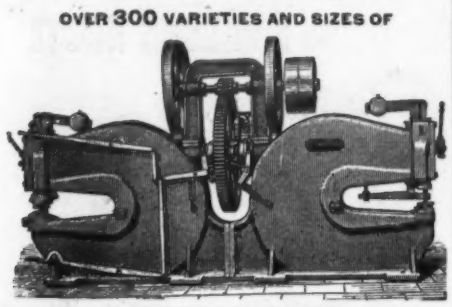

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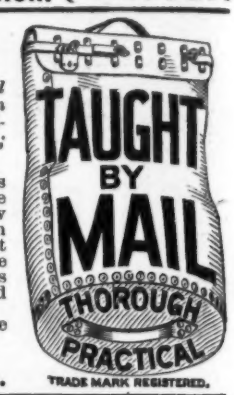

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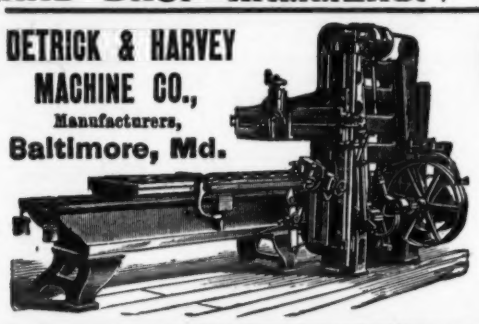

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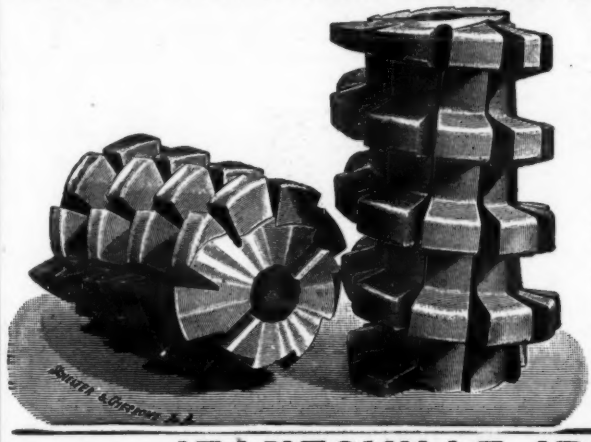

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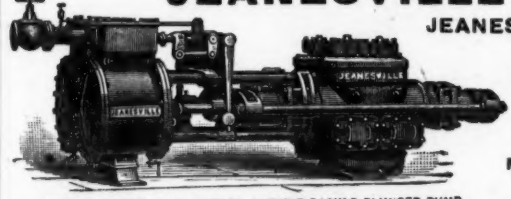

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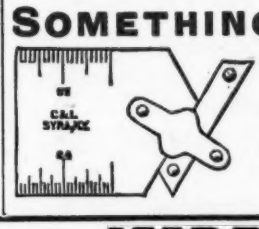

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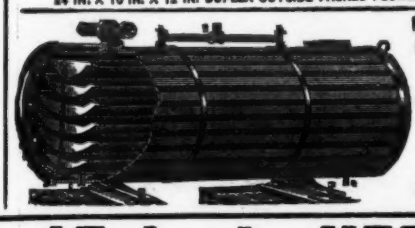

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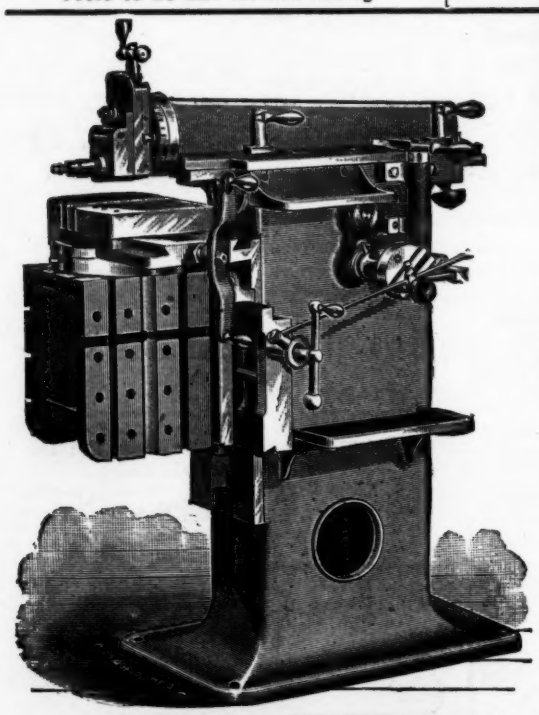

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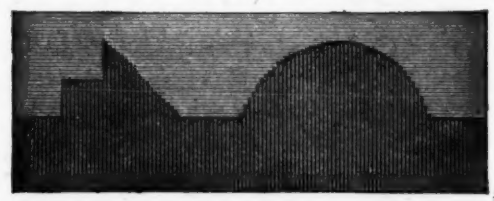

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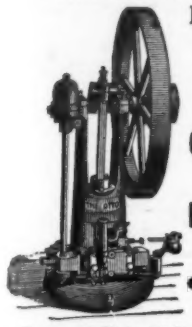

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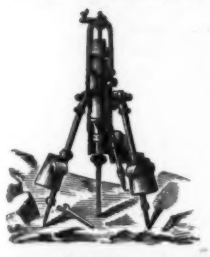

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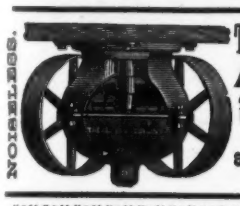

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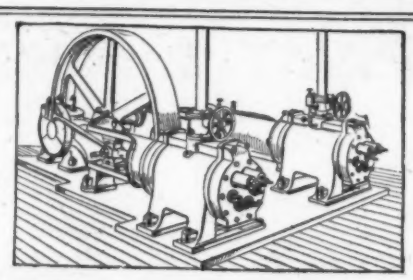

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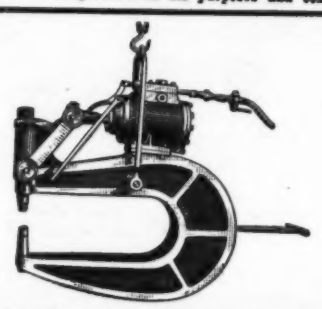

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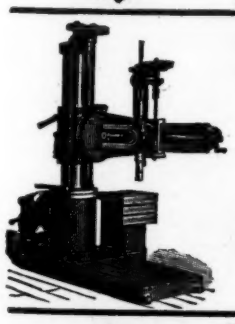

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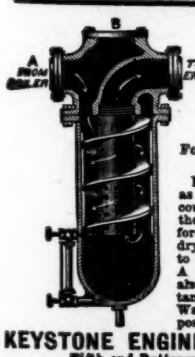

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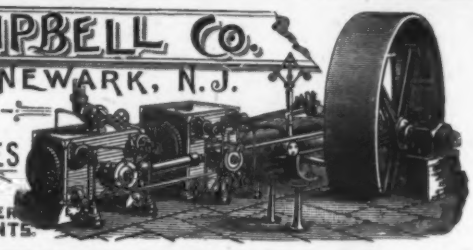

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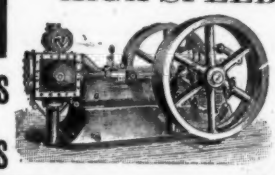

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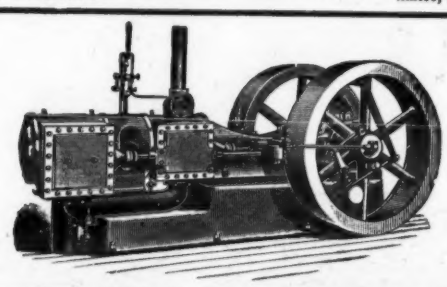

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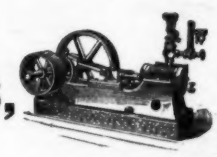

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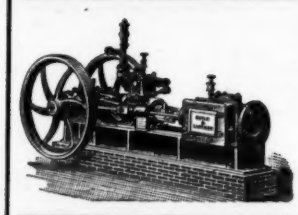

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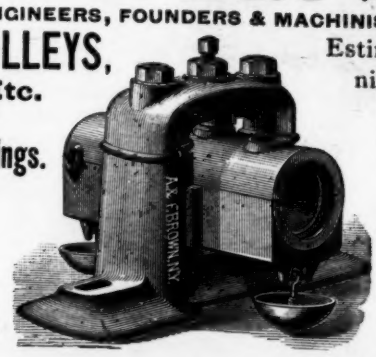

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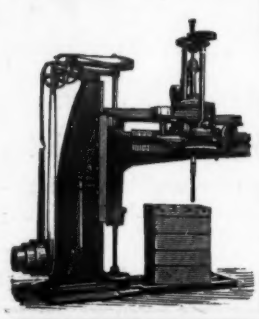

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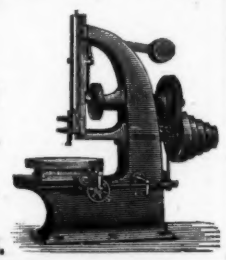

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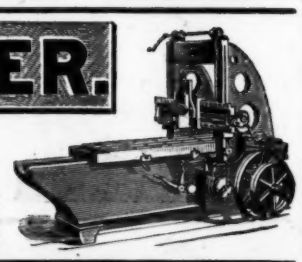

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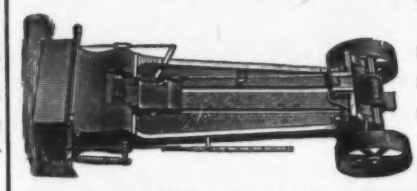

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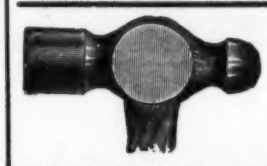

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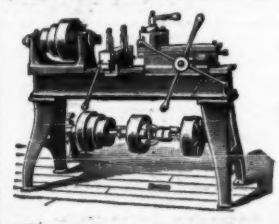

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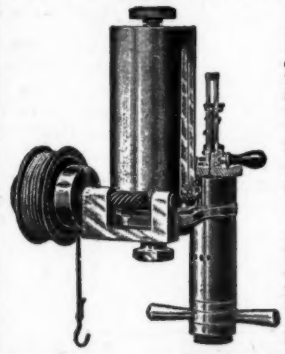

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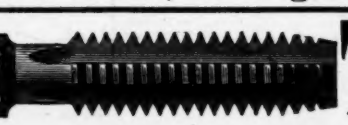

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